NVIDIA GEFORCE GTX 1080 TI
Better than a Titan X **PG. 76**

WHICH DRIVE IS BEST FOR YOU?
SSD vs. NVMe vs. HDD **PG. 20**

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Build a dedicated firewall with IPFire **PG. 62**

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inside

MAY 2017

26
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26
BUILD YOUR OWN RYZEN PC
Budget? No, it's certainly not that—this is our AMD-powered rendering titan.

34
AMD'S NEW HORYZEN
A deep dive into AMD's latest architecture, where we find out what makes Ryzen such an interesting proposition.

42
50 HIDDEN SECRETS OF WINDOWS 10
Delve into the hidden recesses of Windows, and improve the way you use your PC.

52
THE FAN ZONE
Fans are simple, right? Not quite. There are a few things you need to learn before you can pick with confidence.

QUICKSTART

12 **THE NEWS**
Ryzen family grows; Switch is a hit; Windows updates blocked by chips.

18 **THE LIST**
Maximum PC's eight biggest tech annoyances.

Our second Ryzen build this month is more mainstream and wallet-friendly.

R&D

60 **AUTOPSY**
We turn our hands to taking apart Nintendo's handheld Switch.

62 **HOW TO**
Secure your network with IPFire; create your own logo wallpaper; turn a home PC into a VPN server.

70 **BUILD IT**
An in-depth guide to building a more affordable Ryzen PC.

LETTERS

22 **DOCTOR**

94 **COMMENTS**

IN THE LAB

82 **MSI AEGIS TI3**

86 **DELL XPS 13 DEVELOPER EDITION**

91 **GHOST RECON WILDLANDS**

76 **NVIDIA GEFORCE GTX 1080 TI**

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Tuan Nguyen

WELCOME TO THE NEW AMD

BACK WHEN I WAS STILL IN SCHOOL, the PC landscape was largely dominated by Intel. There were more than just two players at that point. For example, does anyone remember Cyrix? AMD, too, was a secondary option. Every available alternative was essentially a licensed or reverse engineered version of an Intel CPU. And while some non-Intel CPUs offered unique features, most if not all of them were plagued by underperforming chipsets and lackluster motherboards. Sure, options were plentiful, but they were all third-rate choices, and the market was hungry for more.

AMD—seemingly out of nowhere—delivered the equivalent of an atomic explosion to the market when it released the Athlon CPU. With the K6 series processor behind it, offering unexciting performance, the new Athlon CPU was a great improvement. AMD further improved on it, and the Athlon 64 was such a monumental performance brute that it was essentially elevated to revered status.

But that was the last great CPU from AMD. Intel's response was to completely overhaul its approach to CPU design, putting huge resources into reclaiming its throne. AMD's later K10 and Bulldozer family CPUs fell behind in both the desktop and server playgrounds, and AMD was again a distant second place.

Athlon had been so good that consumer expectations hit levels that AMD was never able to reach. The loyal following that believed in AMD was left feeling betrayed. And betrayed is, I think, an apt way to describe the last decade. It's no surprise that when AMD announced its new Zen architecture, the world widened its eyes, but remained cautious. There was talk that Zen could be the CPU that makes or breaks AMD. The company knows that it can't falter again—and it hasn't.

Zen, now called Ryzen, is the most exciting thing for consumers from AMD since the original Athlon. Ryzen represents much more than just a CPU for AMD. For the 47-year-old chip company, Ryzen represents a return to the ring. For consumers like you and me, Ryzen revitalizes the CPU race.

AMD has a lot to prove, and Zen will be its combatant on all levels. It might not win every round, but at least it has a puncher's chance.

Does Ryzen renew my faith in AMD's CPUs? Ryzen does more than that—it proves to me that AMD has found its stride. It tells me that the company invested heavily in its R&D, and is willing to jump in for many more bouts. Our tests show that Ryzen is a serious competitor against anything that Intel has to offer. From entry level to high end, AMD shows it can flex some serious muscle.

For me, it's time to let go of those Athlon days. AMD isn't just back—Ryzen shows that there's a new AMD in town.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Ryzen Family Grows Bigger

Ryzen 5 arrives, with 3 following soon after—plus a small bug

WE'VE HAD A WHILE to evaluate AMD's Ryzen 7, and some have been a little harsh; expecting it to beat the best gaming processor ever at its first attempt is asking a lot. Game optimization for Ryzen has barely started, either. It's about performance for the price, and here it hasn't disappointed. AMD has now expanded the range with the Ryzen 5.

Initially, we have four versions. The 3.2GHz 1600 and 3.6GHz 1600X have six cores and 16MB cache, while the 3.5GHz 1500X and the 3.2GHz 1400 make do with four cores and 8MB of cache. Initial prices run from just $169 for the 1400 to $249 for a 1600X. We also get snazzy new coolers: the Wraith Spire and Stealth. The Ryzen 7 significantly undercut Intel's i7, while Ryzen 5 is a more direct price comparison with rival i5s.

The 1600X looks to be a sweet spot here. It's up against the $242 Core i5-7600K, but packs two more cores and three times the threads. Although single-thread power lags slightly, it tops out at 4GHz on boost, behind the 4.2GHz possible with the 7600. Anything that loves lots of threads really thrives.

Later this year, we'll see the Ryzen 3: four-core but without SMT. The 3.4GHz 1200X comes in at $149; drop to 3.2GHz and there's the $129 1100. These go against Intel i3s, with dual cores and HT, which should make for interesting comparisons.

ONE SMALL FLY

So far, the Ryzen has proved capable, but not completely fault-free. A bug has emerged that can potentially lock the system completely. The problem occurs when the chip runs single-precision 128-bit FMA3 operations, Fused Multiply Add. It's not an instruction that gets much use, and the bug only surfaced during benchmarking designed to stretch the floating-point performance from every angle. A BIOS update cures the problem. If you have a Ryzen, there's little cause to worry—to date, no mainstream application has proved vulnerable.

The all-new Ryzen Wraith Max features 150W of TDP clearing potential.

Ryzen's performance under some conditions proved less than expected, or hoped for by some testers, and rumors started that it was down to SMT problems (Simultaneous Multi-Threading). More specifically, it has been claimed that Windows 10 wasn't spreading the workload properly across the cores, not identifying primary and virtual threads properly. However, it transpires there's nothing in this one; AMD has investigated, and went as far as issuing an official denial, along with helpful tips on building Ryzen rigs, including quite a bit on matching memory carefully.

Expecting a fault-free design for something as complex as a new processor architecture is asking a lot. Intel's Skylake suffered a similar FMA3 problem last year. These bugs are nothing, though. The original Pentium had a fundamental bug in the FPU that could return the wrong answer. That led to Intel recalling chips, writing off $475 million, and making some very expensive key rings.

Ryzen is going to put Intel under pressure across the price range. They even use the same basic numbering system, just so it's all perfectly clear. Much mileage can, and certainly will, be made of differences under specific tests, games, and conditions. Intel, as ever, looks to have a slight edge on single-thread grunt, where clock speed is all. To some, an extra frame rate on their favorite game is all that matters, but Ryzen's core and thread count, efficiency, and price continue to impress. The fight is moving to mainstream and budget rigs now, and we suspect it'll be even keener here. **–CL**

> “Ryzen's core and thread count, efficiency, and price continue to impress.

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Nintendo has high hopes for its handheld console, as initial sales are impressive.

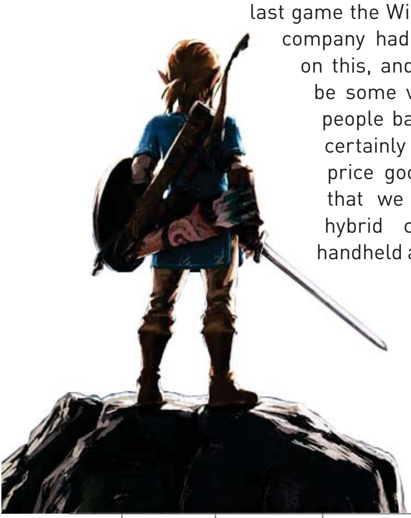
SWITCH A HIT

Production of console is to be doubled

HOPES FOR NINTENDO'S little games console weren't high in all quarters during its protracted development. It missed key deadlines and was subject to much rumor and speculation, and did we really need a hybrid console and handheld anyway? However, sales have been decidedly brisk—1.5 million were shifted during the first week. Nintendo had planned to ship eight million in the first year, but has revised this to 16 million. That puts it in line to outsell the Wii U in under a year.

Nintendo is not the force it once was in consoles, and has been left struggling against the Xbox and PlayStation in recent years. The Wii U didn't shift in the numbers it needed, and developers' attention started to wander. The initial game releases for the Switch were criticized as being rather simplistic and tired, apart from the lovely *Legends of Zelda: Breath of the Wild.* However, momentum is gathering, and it has attracted some decent titles, including *Mario Kart 8, Elder Scrolls V, and Splatoon 2.* Better yet, there are strong indications of a *Pokemon* game in the pipeline.

There have been a few problems, including Joy-Con controllers failing to connect. Its success also signals the end for the Wii U, as developers switch (sorry) to the new hardware. The new *Zelda* will be the last game the Wii U gets. The company had a lot riding on this, and there must be some very relieved people back at HQ—it certainly did the share price good. It seems that we did want a hybrid console and handheld after all. **–CL**



Zelda has been joined by *Mario* and more on the Switch.

WINDOWS UPDATES BLOCKED BY CHIPS

LATEST HARDWARE NOW KILLS WINDOWS 7 AND 8 UPDATES

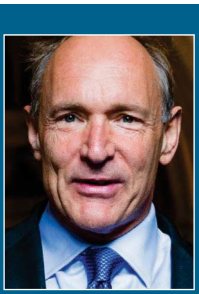
IF YOU'VE BUILT a lovely new Ryzen or Kaby Lake system, and stuck with Windows 7 or 8, there's a catch. According to a Microsoft Knowledge Base article, Windows Update now informs you that you have unsupported hardware when you try to update. The solution, naturally, is an upgrade to Windows 10. The cited reason is Microsoft's "support policy."

We knew this was coming—last year, Microsoft said that Windows 10 would be the only platform to support Kaby Lake, Qualcomm 8996, and AMD Bristol Ridge.

Not many people will be running the latest chips alongside older versions of Windows, so adding support would be unprofitable. But cutting off all updates does look mean-spirited. Older versions of Windows run perfectly well on new silicon; there's no technical problem. This move leaves you out in the cold; you won't even get basic security updates. Boo. **–CL**

CREATOR OF THE WEB SPEAKS

Warns of fake news, data misuse, and worse



PAUL CLARKE FROM WIKIMEDIA COMMONS, THE FREE MEDIA REPOSITORY

ON THE 28TH ANNIVERSARY of the paper that started it all, Tim Berners-Lee issued a warning against what he sees as the biggest problems facing the web through the World Wide Web Foundation.

He highlighted three problems: that we have lost control of our personal data, the rapid distribution of misinformation, and the lack of transparency in political advertising. Smart algorithms mean we are often served carefully targeted information. Articles designed to shock, interest, or appeal to our bias are quickly spread, along with disguised political advertising.

What can be done is a tough one. The gathering of our online data has been a fundamental part of the commercial Internet for years. People still share huge amounts of personal data with little thought of consequences. The increasing use of this data for political ends is most worrying. The Internet is still viewed in the West as empowering; increasingly, it's also manipulative, and worse. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS	TRAGEDIES
✓ **ELECTRIC TATTOO** The use of a new electrically conductive tattoo ink means you can embed circuits into your body.	✗ **GOOGLE AD ROW SPREADS** Four big brands have withdrawn non-search ads from Google after their ads were placed next to extremist videos on YouTube.
✓ **FACEZAM WAS A HOAX** No, you can't get somebody's Facebook profile from a picture of them—a hoax disturbingly close to reality for many.	✗ **PHONE BATH WARNING** A coroner has called for warnings on iPhones after a man electrocuted himself using his phone in the bath.
✓ **WINDOWS INTO CHINA** A version of Win 10 that meets Chinese government approval is ready for market, but the exact modifications remain a mystery.	✗ **GIF WEAPONIZED** A Texas court has classed a gif as a deadly weapon after an epileptic was maliciously sent a flashing image.

Jarred Walton

TECH TALK

AMD Naples Shows Off Scalability

AMD HAS MADE PLENTY OF WAVES with its Zen architecture, which has some really interesting concepts, along with a price that has attracted a lot of attention. One of the key design elements of Zen is that it's supposed to be highly scalable, from ultra-low-power parts for laptops, to desktops and servers, and the real star of AMD's Zen architecture might just prove to be the server processors, code-named Naples.

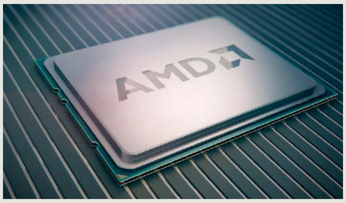
To make everything work properly, AMD reworked many of the building blocks for Zen, including the Infinity Fabric. Zen features a four-core/eight-thread module as its primary building block, combining 512KB of L2 cache per core with a shared 8MB L3 cache, and Ryzen uses two of these modules for the eight-core/16-thread parts. Naples then takes four of those, and puts them in a single package, yielding a 32-core/64-thread part. And in the process, all of the major interfaces are doubled.

That gives Naples a massive eight-channel DDR4 memory controller, supporting up to 16 DIMMs, with 128 PCIe Gen3 lanes of external connectivity. The whole package also comes with an integrated SoC (System on a Chip), so there's no need for external chipsets. One Naples CPU is all that's required to support memory, IO, graphics, and more.

AMD showed off a dual-socket 2U server, running 64-cores/128-threads. The sockets use the Infinity Fabric to talk to each other—in this case, 64 PCIe lanes are used for the 63GB/s interlink between sockets. That leaves 128 total PCIe lanes for external devices, and doubles the memory channels to 16. And AMD rates Naples at up to DDR4-2400 memory speeds with all DIMM sockets populated.

Many server workloads become heavily bound by memory bandwidth and performance, and AMD's Naples delivers more than twice the memory bandwidth of Intel's top dual-socket server. For high-end workloads like HPC, transactional databases, and virtualization, this could give AMD a major advantage.

> “Naples delivers more than twice the memory bandwidth of Intel's top dual-socket server



The massive CPU package houses four eight-core Zen processors.

To drive home this point, AMD put together a head-to-head battle between its Naples server and another server equipped with two of Intel's fastest Xeon part, the E5-2699A v4. Running a seismic analysis workload that involves computationally intensive 3D wave equations, which taxes the entire system, Naples destroyed Intel's Xeon server. With identical core counts and memory speed, Naples was twice as fast, and with a fully armed battlestation sporting 64 cores and DDR4-2400 memory, Naples was 2.5 times faster.

How realistic is this comparison? That's difficult to say, but in the high performance computing scenarios where AMD wants Naples to compete, running software that's optimized for the specific machine architecture is common practice. So, Naples out of the gate should be very impressive, and with plenty of extra cores and memory bandwidth, you'd expect AMD to come out ahead. Zen represents a hard reboot of AMD's processors, with much greater performance and scalability. We may not want to run 32-core/64-thread processors on our desktops, but servers can easily make use of such capabilities.

Naples is slated to launch in Q2 of 2017, though AMD hasn't revealed pricing or the various models yet. It will be partnering with other companies to bring the servers to market, and Naples should garner a lot of interest. Intel will also have new Xeon parts later this year, based on Skylake/Kaby Lake, which may close the gap. I wouldn't expect to see a rapid overhaul of the existing IT infrastructure, as companies tend to be a lot more cautious, but it will be good to have a competitive AMD server solution again.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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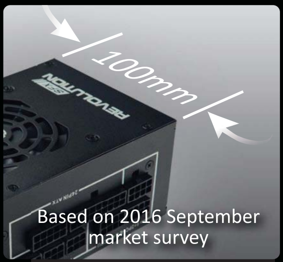

Based on 2016 September market survey

SFX-to-ATX PSU Adapter Bracket

Innovative Dual-fan Power Supply Creates Active Ventilation

DUOFlow™ Design + FMA Technology

REVOLUTION DUO

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- FMA Fan Speed Control
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FMA
Fan-Speed Manual Adjustment provides extra cooling

Perfect for PC Cases with PSU Shrouds

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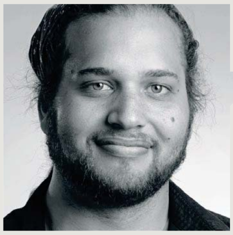


Alex Campbell

OPEN SOURCE

The Open-Source View of Outer Space

FOR MOST PEOPLE, the closest they're ever likely to get to working in a space program is playing the game *Kerbal Space Program.* That's probably not going to change, but now you can at least feel as though you're getting a deeper glimpse into what it takes to go to space.

At the beginning of March, NASA made a large library of software programs available to the "public." The software runs the gamut from code to control propulsion systems to environmental science to boring old project management tools.

But what's with the quotes around "public"? Of the 975 software projects that have been released to the public, only 210 (about 22 percent) are released as open source. Many others are available as a government release, of which many are only available to other government agencies or government contractors. Getting access to one-fifth of what NASA released is better than nothing, but I'm a little thrown off by the decision to advertise the offering of software that only other government officials or contractors can actually look at.

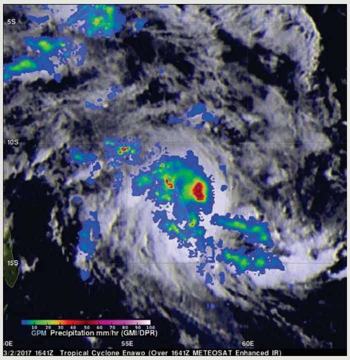
First off, I'm a firm believer in the concept behind Code For America, an organization that looks to enlist young programers to create open-source applications in the public interest. Offering up code in an open-source format or Git repository for people to contribute to could be a huge resource for an agency that's been cash-strapped for decades.

Second, I'm forced to wonder why NASA would put links for code on a public website when some of that code isn't accessible to the public. It's like telling a kid in a toy store, "You can play with any toy you want, except those. Those are special toys." It's also curious that some of the tools are hosted at SourceForge. Some of the projects have Subversion (SVN) repositories available, but most open-source projects use Git nowadays. It would be great to see these projects hosted on a GitLab server somewhere. (GitLab is akin to a self-hosted GitHub.) Having a single central server to host Git repos would be much more efficient than the slapdash collection of links that are available now.

> It's fun to poke around and take a peek at what's been under NASA's hood for the past few years.

Nevertheless, I'm excited to see tools that are literally used by rocket scientists made available for everyone. One example is NASA's General Mission Analysis Tool, or GMAT. According to the ReadMe, "GMAT is a space trajectory optimization and mission analysis system developed by NASA and private industry in the spirit of the NASA Vision." Basically, you can use GMAT to plan orbits of stuff shot into space. Neato. And NASA released it under the Apache license, to boot. In addition to the source, you can get the application for Red Hat Enterprise Linux and Ubuntu.

Some other projects, such as the Global Precipitation Space and Ground Radar Comparison Software, are released under NASA's Open Source Agreement (NOSA). Version 1.3 of the NOSA has been certified by the Open Source Initiative as a valid open-source license, but the Free Software Foundation does not consider the license free software.


5S
10S
15S
10 20 30 40 50 60 70 80 90 100
GPM Precipitation mm/hr (GMI/DPR)
0E
55E
60E
3/2/2017 1641Z Tropical Cyclone Enawo (Over 1641Z METEOSAT Enhanced IR)

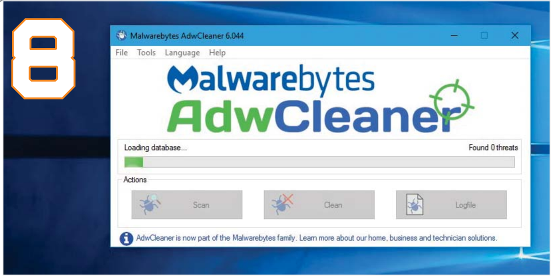
This Tropical Rainfall Measuring Mission satellite image was made using open-source software.

If you want to check out any of these projects, just head over to https://software.nasa.gov. You can browse projects by category or search by keyword. Although a lot of the software isn't terribly useful for those of us who aren't rocket scientists, it's fun to poke around and take a peek at what's been under NASA's hood for the past few years. And for those who are engineers or rocket scientists, there might just be some goodies waiting for your next project.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

MAXIMUM PC's TOP EIGHT TECH ANNOYANCES

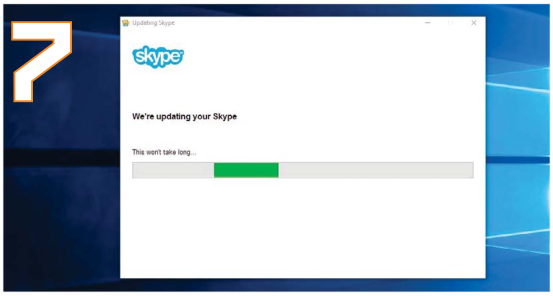

8
Malwarebytes AdwCleaner 6.044
File Tools Language Help
Malwarebytes
AdwCleaner
Actions
Scan
Clean
Logfile

Loading database...

Found 0 threats

AdwCleaner is now part of the Malwarebytes family. Learn more about our home, business and technician solutions.

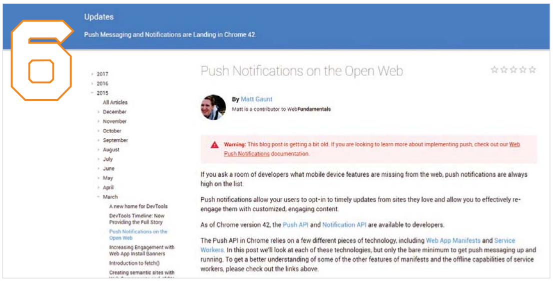
HIJACKING It's 2017, and we have apps that think it's OK to add a search bar and change your homepage.


7
Updating Skype
skype

We're updating your Skype

This won't take long...

NOT CLOSING If we close a window, we want it to close. So why do we have to right-click and select "Quit"?


6
2017
2016
2015
All Articles
December
November
October
September
August
July
June
May
April
March
A new home for DevTools
DevTools Timeline: Now Providing the Full Story
Push Notifications on the Open Web
Increasing Engagement with Web App Install Banners
Introduction to fetch()
Creating semantic sites with

Updates

Push Messaging and Notifications are Landing in Chrome 42.

Push Notifications on the Open Web

By Matt Gaunt

Matt is a contributor to WebFundamentals

Warning: This blog post is getting a bit old. If you are looking to learn more about implementing push, check out our Web Push Notifications documentation.

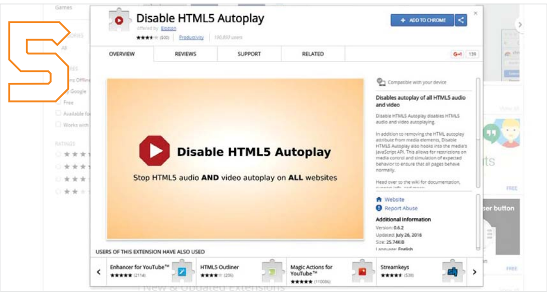
If you ask a room of developers what mobile device features are missing from the web, push notifications are always high on the list.

Push notifications allow your users to opt-in to timely updates from sites they love and allow you to effectively re-engage them with customized, engaging content.

As of Chrome version 42, the Push API and Notification API are available to developers.

The Push API in Chrome relies on a few different pieces of technology, including Web App Manifests and Service Workers. In this post we'll look at each of these technologies, but only the bare minimum to get push messaging up and running. To get a better understanding of some of the other features of manifests and the offline capabilities of service workers, please check out the links above.

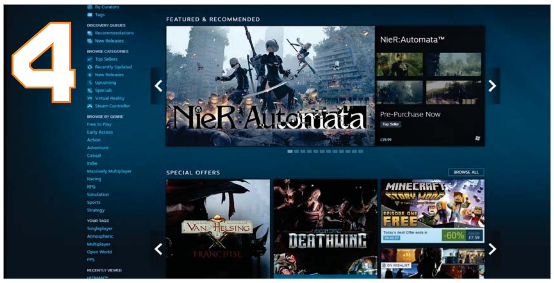
PUSH NOTIFICATIONS This site wants to notify you of any updates, do you agree? No thanks, we're fine.


5
Disable HTML5 Autoplay
ADD TO CHROME
OVERVIEW
REVIEWS
SUPPORT
RELATED
Disable HTML5 Autoplay
USERS OF THIS EXTENSION HAVE ALSO USED
Enhancer for YouTube™
HTML5 Outliner
Magic Actions for YouTube™
Streamkeys

Stop HTML5 audio AND video autoplay on ALL websites

Disables autoplay of all HTML5 audio and video

AUTOPLAYING Spot a story, go to a site, and your headphones burst into life as an unrelated video kicks in.


4
FEATURED & RECOMMENDED
NieR:Automata™
NieR:Automata
Pre-Purchase Now
SPECIAL OFFERS
BROWSE ALL
VAN HELSING
DEATHWING
MINECRAFT STORY MODE
FREE
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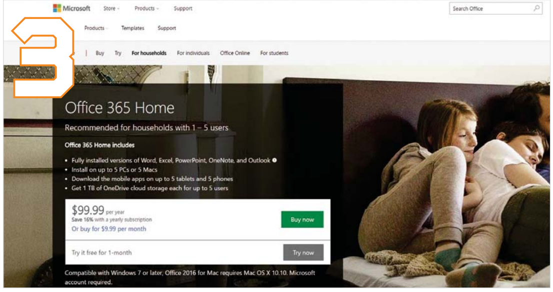
STEAM UPDATES Daily patches are necessary, but if you don't have those games, why does it need to restart?


3
Microsoft
Store
Products
Support
Search Office
Products
Templates
Support
Buy
Try
For households
For individuals
Office Online
For students
Buy now
Try now

Office 365 Home

Recommended for households with 1 – 5 users

Office 365 Home includes

- Fully installed versions of Word, Excel, PowerPoint, OneNote, and Outlook
- Install on up to 5 PCs or 5 Macs
- Download the mobile apps on up to 5 tablets and 5 phones
- Get 1 TB of OneDrive cloud storage each for up to 5 users

$99.99 per year

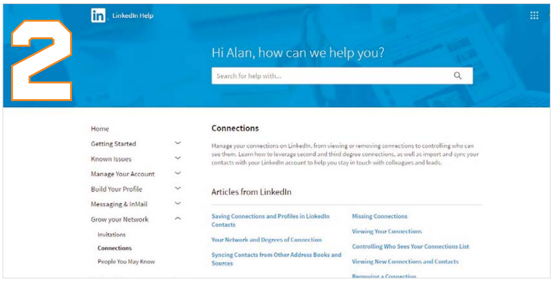
Save 16% with a yearly subscription

Or buy for $9.99 per month

Try it free for 1-month

Compatible with Windows 7 or later, Office 2016 for Mac requires Mac OS X 10.10. Microsoft account required.

OFFICE 365 NAGS Being constantly nagged to use Office 365 by Win 10 really gets the blood pressure rising.


2
LinkedIn Help
Home
Getting Started
Known Issues
Manage Your Account
Build Your Profile
Messaging & InMail
Grow your Network
Invitations
Connections
People You May Know
Saving Connections and Profiles in LinkedIn Contacts
Your Network and Degrees of Connection
Syncing Contacts from Other Address Books and Sources
Missing Connections
Viewing Your Connections
Controlling Who Sees Your Connections List
Viewing New Connections and Contacts
Removing a Connection

Hi Alan, how can we help you?

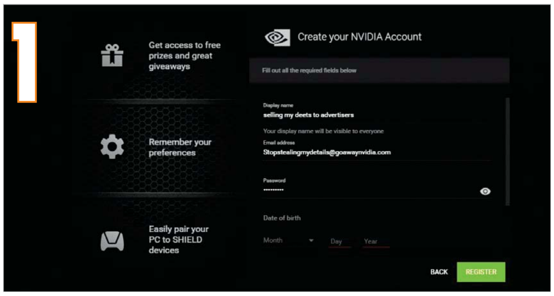
Search for help with...

Connections

Manage your connections on LinkedIn, from viewing or removing connections to controlling who can see them. Learn how to leverage second and third degree connections, as well as import and sync your contacts with your LinkedIn account to help you stay in touch with colleagues and leads.

Articles from LinkedIn

CONTACT BEGGING Social media's obsession with knowing all our friends' email addresses is disturbing.


1
Get access to free prizes and great giveaways
Remember your preferences
Easily pair your PC to SHIELD devices
BACK
REGISTER

Create your NVIDIA Account

Fill out all the required fields below

Display name: selling my deets to advertisers

Your display name will be visible to everyone

Email address: Stopstealingmydetails@goawaynvidia.com

Password: ••••••••••

Date of birth: Month Day Year

GEFORCE EXPERIENCE Having to give an email address to keep hardware up to date makes no sense.

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Server Quality, Built for Gaming

Gaming &
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HEAD TO

BY **JEREMY LAIRD**

Magnetic Hard Drive vs. SATA SSD vs. M.2 NVMe

Storage was once the final frontier of PC performance, and the last component to become fully solid state. Today, the latest M.2 SSDs powered by the new NVMe protocol and hooked up via zappy PCIe connections deliver performance that a conventional hard drive wouldn't recognize. Yet the hard drive isn't dead. Not when it offers so much capacity for so little money. Meanwhile, the trusty SATA SSD offers a combination of compatibility and speed that's awfully compelling. Time to find out which storage technology is the best.

ROUND 1

Performance

You might think the choice between old-school magnetic drives, conventional SATA SSDs, and the latest M.2 items was a total no-brainer. For the most part, you'd be right. Magnetic drives, with their quaintly spinning platters and delicately servo'ed read heads, certainly don't stand a chance when it comes to raw performance. They're OK at sequential workloads, albeit offering about one tenth the speed of a decent SSD at best, but they really suck when it comes to random access.

SATA SSDs, meanwhile, may be pretty quick, even by modern standards, but they're ultimately held back by both the SATA interface itself, which caps peak performance at about 550MB/s, and the elderly AHCI control protocol, which was never intended to be used with solid-state tech.

So it's M.2 and its zippy PCI Express interconnect that easily rules the day, with the latest drives topping 3GB/s for peak performance, and packing the highly optimized NVMe control protocol. The catch is system compatibility, and that's why M.2 isn't a complete no-brainer. Especially for older PCs, a SATA SSD may be the most painless path to decent storage performance.

Winner:
M.2 NVMe

ROUND 2

Capacity

Spare a thought for the poor old conventional hard drive. In this brave new age of solid-state computing, the very notion of moving parts seems utterly antediluvian. But this is its chance to shine. When it comes to raw storage capacity, those spinning magnetic platters positively annihilate the solid-state alternatives.

Perhaps most impressive is the fact that, while CPU performance has somewhat stagnated, and the power of Moore's Law to predict chip shrinkage may well have stalled, the ability of magnetic hard drive makers to pack in ever more capacity hasn't waned at all. Innovations such as the use of helium to reduce internal air shear saw the 10TB barrier cracked last year in the consumer drive space, and that progress looks set to continue, albeit at quite a price.

Aim a little lower, and the likes of a 3TB drive are now available for as little as $75—and even less if you are willing to roll the dice on a refurb. The only caveat is that if you don't have a big video or games library, you probably don't need a big hard disk at all, and a much nippier budget SSD of around 500GB is probably all most mainstream users will ever actually need.

Winner:
Magnetic hard drive

ROUND 3

Compatibility

Given the radical change in technology represented by solid-state storage, it's surprising that it wasn't accompanied by major compatibility problems. However, thanks to adopting existing standards, including the SATA interface and support for legacy IDE and AHCI control protocols, SSD compatibility has been, for the most part, a breeze. SATA ports have been standard on nearly all motherboards for a very long time.

So, whether your SATA drive is solid state or magnetic isn't hugely consequential in compatibility terms. But things get more complicated when it comes to those newfangled M.2 drives. Any motherboard more than two years old almost certainly lacks an M.2 port. What's more, having an M.2 port doesn't automatically mean support for the highly desirable NVMe control protocol.

Granted, it is possible to buy M.2 PCI Express adapter boards to add support to legacy motherboards. But the older your mobo, the more likely it is to have issues supporting booting from the drive and, again, that NVMe protocol. It's also worth remembering that your M.2 drive will only be as fast as the PCIe lanes provided by the motherboard.

Tie:
Magnetic hard drives
and SATA SSDs

HEAD

WD
2 TB
SATA / 64 MB Cache
WD20EZRX
WD Green
Desktop Hard Drive

crucial
The Memory Experts

V-NAND SSD
950 PRO M.2
512GB
SAMSUNG
nvm EXPRESS

ROUND 4

Value

What price do you put on capacity or performance? That's the conundrum you face when sizing up the value of the various storage options. You cannot maximize both attributes. Solid state prices have come down, but when it comes to GB/$, they're still obliterated by traditional magnetic storage.

A $75 3TB hard disk, for instance, works out at around 40GB per dollar. Matching that capacity with an SSD will cost you roughly 10 times as much. Meanwhile, even the sweet spot of current SSD GB/$, which is probably the 1TB segment, only delivers roughly 3GB per dollar. And that's for a budget-oriented SATA SSD. The fanciest M.2 drives look like even worse value.

Of course, shift your priorities toward performance, and the tables are resolutely turned. When it comes to random access performance, which is especially critical for everyday performance and responsiveness, SSDs can be over 100 times faster than magnetic drives. That said, the cheaper end of the SATA SSD spectrum probably gives you the best bang for buck. But take care to avoid the very lowliest, which often use cheap controllers intended for USB drives, to save money.

Winner:
SATA SSD

ROUND 5

Durability

This is the most contentious metric. Firstly, that's because durability can mean different things. For a portable PC, a solid-state drive is a huge bonus, and has the potential to be far more robust than a fragile magnetic drive, with spinning platter and moving read heads.

For a desktop PC, where physical shocks and exposure to extreme temperatures are less common, durability is all about the ability to soak up a lot of bandwidth, without losing performance and capacity, or failing.

The early days of SSDs were grim in that regard. Outright failure wasn't that common, but a drop-off in performance was inevitable over time. Six months of heavy use could truly hammer those first SSDs. Since then, multiple technologies, including advance wear leveling and garbage collection routines, have dramatically improved the situation. Of course, the performance of hard drives can go off over time, too, with data fragmentation. But that's usually fixable with a little defragging. Overall, however, the very best M.2 SSDs can be had with warranties and life expectancies of around five years, even with very heavy workloads. On balance, they're probably now the most robust storage technology.

Winner:
M.2 NVMe

And the Winner Is...

Call us indecisive, but the final verdict on which storage medium is best really has to come down to your own personal usage model. If you want to maximize sheer capacity, for instance, a conventional hard drive is an absolute no-brainer. It's literally an order of magnitude cheaper. Even if money is of no consequence, one can only connect so many drives, and hard disks are simply bigger.

On the other hand, if performance is your exclusive priority, then one of the latest M.2 SSDs with support for the NVMe protocol should be your weapon of choice. These solid-state devices now deliver performance measured in gigabytes per second, which you have to admit, is pretty stunning.

However, perhaps the best overall compromise of performance, compatibility, and value for now is an SSD hooked up via the good old SATA interface. It's a fantastic way to give and aging PC new life.

So, before you splash out on a new storage device, think about whether your priority is speed, cost, or a balance of the two, then take your pick.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> OS Choices
> SSD Upgrades
> BIOS Passwords

OS Alternatives

Aloha, Doctor. Currently, my PC is running Windows 7 Ultimate, not because I am cheap, but because I refuse to throw money away. Every time I have chosen to buy the latest Microsoft operating system, I end up paying thousands of dollars for other applications I already own because they no longer work properly.

Working as a photographer who needs his monitors to stay clean, I passed on Windows 8 because of its Metro user interface (even though the move to a UEFI would have fixed multiple issues with my 24-plus hard drives). Windows 10 looks a lot better, but I just can't bring myself to buy all of my software over again.

So, besides Apple and Linux, are there any other alternatives available to address what I consider to be corporate greed?

–Gordon

The still-majestic Cosmos 1000 lacks USB 3.0 ports.

THE DOCTOR RESPONDS: How much convenience are you willing to give up for your principles? The Windows ecosystem isn't perfect, but it provides the greatest breadth of choice when it comes to picking tools for work and play. If you've run into compatibility issues upgrading from one version of Windows to another, it might be worth considering better-supported software, rather than razing your hard drive and starting over.

The Doc sympathizes with those who eschew Windows and MacOS for a foundation built on free and open-source software. But why disregard Linux as well? Linux Mint, Ubuntu, Debian, Fedora, and OpenSUSE are all popular distributions made stronger by rich libraries of open-source tools and apps. FreeBSD or Haiku would probably be next on the Doc's list if you are serious about going the alternative operating system route.

Whichever direction you go, start by installing VMware Workstation Player on your Windows 7-based PC. That will give you an opportunity to try the various options without doing irreparable damage to your existing setup.

Easier Than You Think

Dear Doc, I'm planning on building a PC in an NZXT S340 Elite chassis using an EVGA SuperNOVA 850W power supply, a Gigabyte Z270-based Gaming 7 motherboard, Intel's Core i7-7700K, a GeForce GTX 1080, 32GB of G.Skill DDR4 memory, Samsung's 500GB 960 EVO in an M.2 form factor, a WD 2TB hard drive, and NZXT's Kraken X52 cooler. While there's no time pressure, I don't want to screw this up and destroy any of the components I'm buying. Cost is important, but not the primary consideration.

I've read that it's a good idea to assemble all the components outside the case to verify they work properly before installing them. Assuming that this is a reasonable approach, my plan would be to install the RAM, graphics card, CPU, and M.2 SSD on the motherboard. However, the Z270-based board has two M.2 connectors, so which should I use, given that I'm installing a GeForce GTX 1080? From there, I'm guessing I'd connect my monitor to the graphics card, hook up to the PSU, and power up.

The next step, I imagine, would be to install Windows 10 from a thumb drive. Can I install Windows without attaching the closed-loop cooler, or does this put the CPU at risk? Ideally, I'd set the cooler up after transferring my hardware to its final resting place in the case, at which point I could also plug in the fans and install the hard drive.

I'm perhaps most nervous about installing Windows 10. As long as I've built PCs, most of my problems have come from one Microsoft product or another. Any comments or advice you could pass my way would be much appreciated.

–Peter Luptovic

THE DOCTOR RESPONDS: Assembling and powering up components outside of your case is a good way to troubleshoot known issues. If all of this machine's hardware is new, though, build it up into the chassis straight away to avoid accidental bumps, falls, or spills. Some enthusiasts insist on installing their CPU and memory on an open test bench, but NZXT's S340 is roomy enough to work inside.

That should address your question about installing Windows without a heatsink and fan on your CPU, too. Intel's Core i7-7700K does include sensors and protections to

↘ submit your questions to: doctor@maximumpc.com prevent the type of damage insufficient cooling would cause. Those aren't features you want to test, though. Make sure your Kraken X52 is attached properly before applying power to the 7700K.

When it's time to install the Samsung 960 EVO, you'll have to pick between the Z270X-Gaming 7's M.2 slots. One shares bandwidth with SATA ports 4 and 5, while the other shares bandwidth with the four-lane PCIe slot. So long as you hook the 2TB WD hard drive up to SATA port 0, 1, 2, or 3, drop the SSD into M2M_32G.

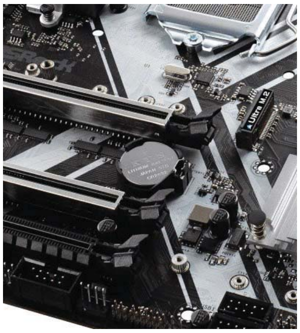
Finally, don't worry too much about Windows 10. On a modern platform such as yours, the installation should be reasonably painless.

Modernizing a Classic

Hello, Doctor! I have a Cooler Master Cosmos 1000 case that I absolutely love, and in the near future I plan to swap out my old hardware and install modern components. This would include updating to native support for USB 3.0. Is there a replacement front I/O panel that would add this functionality to the Cosmos chassis? I haven't really gotten anywhere with my searches online. **–Matt Cathey**

THE DOCTOR RESPONDS: A lot of Cosmos 1000 owners would like to see Cooler Master support the old (but still beautiful) case with a replacement I/O panel sporting USB 3.0 connectivity. Unfortunately, no such upgrade seems to exist.

Short of selling the chassis and buying a Cosmos II, it may be best to install a USB 3.0-equipped 3.5-inch bracket into one of your vacant drive bays. Cooler Master used to make these (RA-USB-3035-IN), and you can still get them shipped in from overseas.


Remove the CR2032 battery to clear BIOS passwords.

Storage Upgrade Woes

Hello Doc, I've been trying to add SSDs to a system I assembled back in 2010, which is based on an Asus Rampage II Gene motherboard running Windows 7. After updating the BIOS to v.1701 back in 2012 and installing a Core i7-980 CPU, I left its internals alone. I originally considered retiring the PC. But it works fine, and I think I can get a few more years out of it by replacing the mechanical hard drives with a pair of Samsung 850 Pro SSDs.

Since I'm writing in, you can imagine my simple upgrade hasn't gone well. After mirroring my C:\ drive to one SSD, I tried to reboot and failed. Resetting the BIOS Storage Configuration option to AHCI, and changing JMicron 36x ATA Controller to IDE/AHCI did nothing to help. As I re-imaged and swapped drives, I noticed a few behaviors that I thought might indicate the nature of this failure.

Question 1: After the new drive was swapped in, I had to go through Windows' repair process, which eventually aborted. But once the BIOS was set back to IDE mode, I could get the original drive to work again. And if I removed the second hard drive, the system wouldn't reboot even with the original disk in place. Naturally, I marked the SATA cables to make sure my connections didn't change. Changing back to AHCI, the machine wouldn't boot with the original drive in place. I'm not sure why switching to AHCI would prevent me from booting, all else remaining constant.

Question 2: During attempts to boot from the SSD, a blue screen flashed on and off. I would love to know what the message said, but I needed more than 12 milliseconds to read it, and I can't seem to pause the loop.

Question 3: When the SSD was in place, it showed up in the BIOS correctly. Moreover, Windows' repair routine had to be running from it. The other HDD is only used for data; it doesn't have any OS files. How could the SSD run in limited mode and fail to boot?

Asus mentions a BIOS/Secure Boot issue that might complicate installation of a new boot drive. This might also explain why I'm having a hard time booting from the original hard drive after the SSD fails the repair process. But I can't find the feature Asus is talking about, so I may not have it in this older BIOS.

Any suggestions would be welcome! I'd love to keep this machine going with a faster storage subsystem.

–Jon Anderson

THE DOCTOR RESPONDS: Worst-case scenario, you reinstall Windows on one of the new SSDs and enjoy a reinvigorated Gulftown-based machine. There's no reason to let a drive swap slow you down. But first let's try bringing your existing operating environment back from the dead.

You should give Linux a try if you're tired of Windows.

When you changed the BIOS from IDE to AHCI mode, there's a good chance Windows was still trying to load your IDE controller's drivers, causing the crash. If you're still able to get the original disk to boot with the Storage Configuration set to IDE, try this (copied straight from Microsoft):

- Click "Start," type "regedit" in the "Start Search" box, and then press Enter.
- If you receive the "User Account Control" dialog box, click "Continue."
- Locate and then click the following registry subkeys: HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\Msahci
- In the pane on the right, right-click "Start" in the "Name" column, then click "Modify."
- In the "Value" data box, type "0" and then click "OK."
- On the "File" menu, click "Exit" to close Registry Editor.

Upon restarting, Windows should load the AHCI driver and boot. If that works, try re-imaging to the SSD. Leave the BIOS set to AHCI mode and see if you have better luck.

Kill a BIOS Password

Hi Doctor, I have a desktop with Windows 7 Pro on it. I tried to access the BIOS in order to perform a fresh installation, but the firmware is password-protected and I don't have the original owner's contact information. Is there a software or hardware trick to remove or reset the BIOS password?

–Michael Ward

THE DOCTOR RESPONDS: Most motherboards rely on 3V CMOS batteries for saving BIOS settings. Make sure your PC is turned off, disconnect power to the board, and locate the button cell. Remove it by pressing on the retaining clip. Wait a minute or so before popping it back and restoring power. You should get a message that the BIOS settings were restored to their defaults. The Doc tested this on multiple boards in the lab with a 100 percent success rate. ⏻

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Build Your Own Ryzen PC

Budget? No, it's certainly not that—this is our AMD-powered, plug-and-play, rendering titan

BY ZAK STOREY

WE'VE GONE A LITTLE AMD MAD this issue, as you can probably tell. The plucky underdog has really rattled the cages of the establishment. And, yes, although there are bugs—slowly being ironed out by developers and OS engineers alike—the value proposition put forward by AMD's new line-up of 7-series chips opens a whole plethora of new opportunities for those looking to supercharge their HEDT experience.

But first, let's get one thing straight: This is, by no means, a cheap build. Coming in at almost $5,300, this system holds nothing back when it comes to part selection, particularly on the storage front. Slapping 64GB of high-spec DDR4, 22TB of storage, and an external NAS together bumps the price up by a staggering $3,127, accounting for an incredible 59 percent of the total expense. Selecting 32GB of 2,400MT/s DDR4, a 250GB PCIe SSD, and two 2TB HDDs instead would drop the price by $2,484, bringing it to a far more reasonable $2,804 for a high-end rendering station.

That said, as far as computational performance goes, and value per dollar, the core spec of this build is impressive, to say the least, smashing almost all of our system benchmarks, and hammering our zero-point system into the ground. With Ryzen's eight-core processors now cheaper than some of Intel's four-core Kaby Lake offerings, this could mark the beginning of the end for mainstream quad-core systems…

RYZEN PC INGREDIENTS

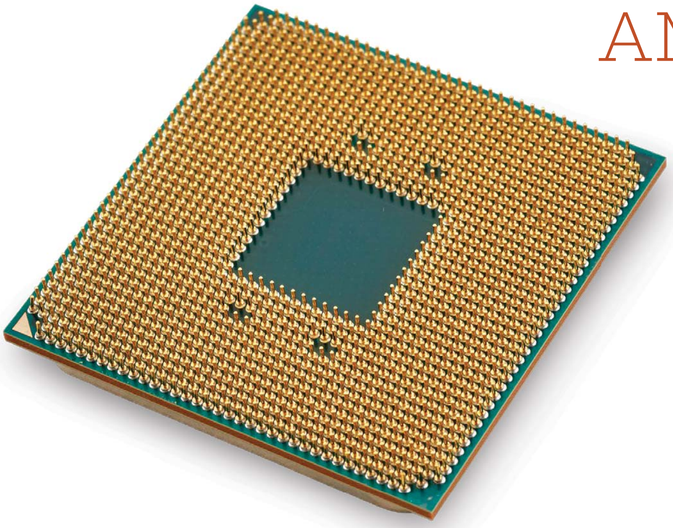
PART		STREET PRICE
CPU	AMD Ryzen 7 1800X	$497
CPU Cooler	EKWB EK-XLC Predator 240 AIO	$200
Mobo	Gigabyte Aorus GA-X370-Gaming 5	$195
RAM	G.Skill TridentZ Series 64GB (4x 16GB) 3,200MT/s	$670
OS Storage	Samsung 960 Pro 2TB M.2 PCIe SSD	$1,298
Data Storage + NAS	2x HGST Ultrastar He10 7,200rpm + WD Diskless My Cloud EX2 Ultra NAS	$1,159
GPU	EVGA GeForce GTX 1080 Ti Founder's Edition	$700
Case	Cooler Master MasterCase Maker 5t	$250
PSU	Corsair RMX 650W 80+ Gold	$104
Cooling	3x EK Vardar F4-120ER 120mm	$115
Operating System	Windows 10 OEM	$100
TOTAL		**$5,288**

NVIDIA
960 PRO
SAMSUNG

GTX 1080Ti
AORUS
GIGABYTE
GA-AX370-Gaming 5
HDMI
Intel GbE LAN
USB 3.1 Gen 2
UEFI DualBIOS
NVMe PCIe Gen3x4 22110
AMD RYZEN
CORSAIR
Vardar
F4-120 (2200 rpm)
Vardar
Predator
Vardar
Predator

CPU

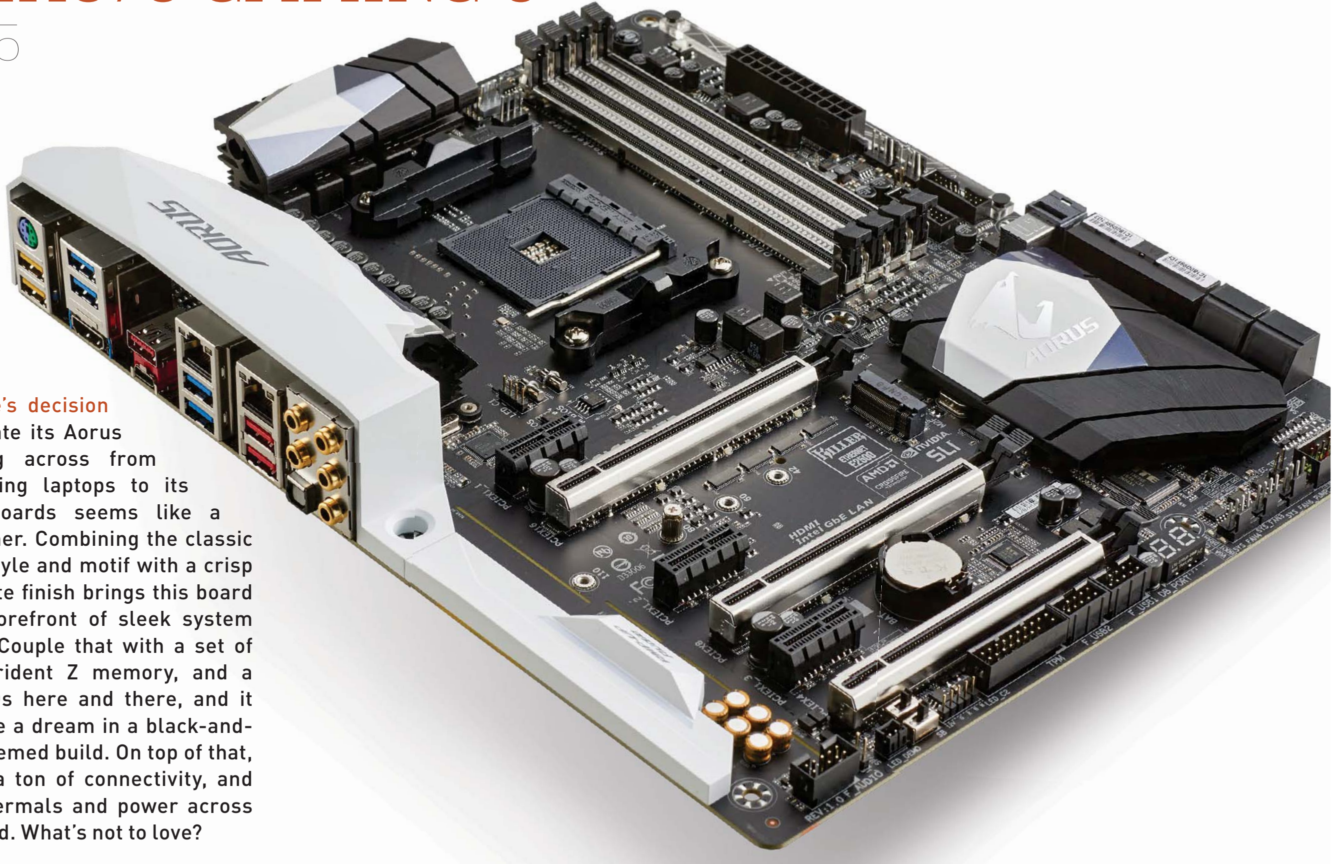
AMD Ryzen 7 1800X $497



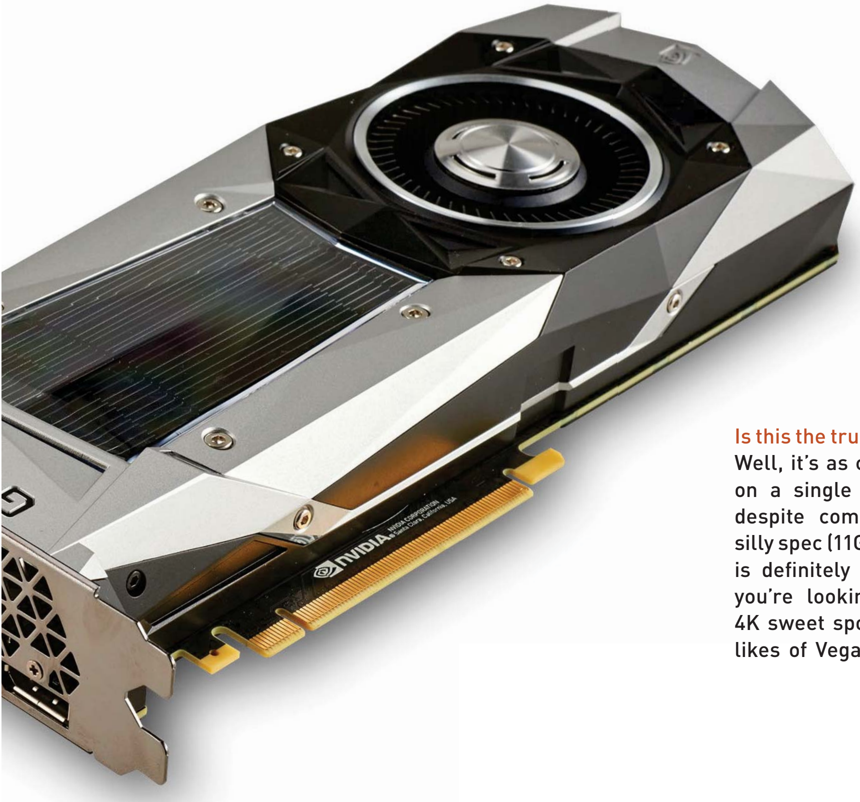
It's weird having choice again, even in this climate of Ryzen 7 CPUs being available. For the best bang for your buck, you have three options: the 1700, the 1700X, and the 1800X. In theory, the best chips for overclocking should be the 1700X and the 1800X—however, we've heard rumors suggesting that some 1700 chips are actually capable of out-clocking even the top-end 95W parts. That said, for stock clocks and reliability's sake, the 1800X is king of the hill, and although it may not be the best-value processor out there, it's still $500 less than its Intel equivalent.

MOTHERBOARD

GIGABYTE AORUS GA-X370-GAMING 5 $195



Gigabyte's decision to migrate its Aorus branding across from its gaming laptops to its motherboards seems like a no-brainer. Combining the classic Aorus style and motif with a crisp mat white finish brings this board to the forefront of sleek system design. Couple that with a set of white Trident Z memory, and a few LEDs here and there, and it would be a dream in a black-and-white themed build. On top of that, there's a ton of connectivity, and solid thermals and power across the board. What's not to love?



GPU

EVGA GEFORCE GTX 1080 TI $700

Is this the true king of 4K gaming? Well, it's as close as you can get on a single card. The 1080 Ti, despite coming with a slightly silly spec (11GB of VRAM anyone?) is definitely the card to have if you're looking to hit that AAA 4K sweet spot. At least until the likes of Vega and Volta drop. On top of that, thanks to its CUDA core architecture, it syncs up exceptionally well with the likes of Adobe's Creative Suite—most notably Premiere Pro—making short work of all your HDR 4K rendering loads. The only drawback to this build? We wish we had another.

CASE

COOLER MASTER MASTERCASE MAKER 5T $250

At first glance, the premium-looking MasterCase Maker 5t checks a lot of our boxes. Capable of supporting coolers up to 280mm in the front and roof, it's a modular heaven, with multiple configurations available through Cooler Master's in-house store. Unfortunately, it proved a bit more troublesome than we'd have liked once we got to building inside it, but it's hard to deny the build quality CM has leveraged on this. Although the sharp lines and bold red coloring might not be to everyone's tastes, it's a top-quality case, for people with very specific requirements.

Time to Get Building

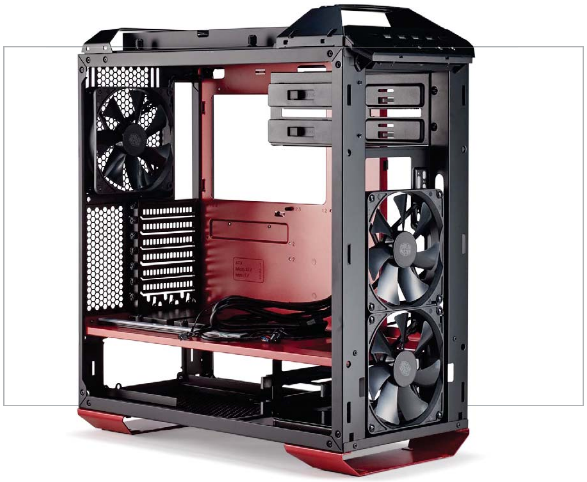
A step-by-step guide to piecing together your very own Ryzen rendering PC

GTX 1080Ti
AORUS
GIGABYTE
RYZEN
Vardar
Vardar Predator
Vardar Predator

1 STRIP THE CHASSIS

SO YOU'VE GOT YOUR PARTS, a suitable workspace set up, free from static-inducing materials, a dependable set of tools, including a couple of Phillips head screwdrivers, a ton of cable ties, and you're ready to go. First thing you're going to want to do is strip down the chassis to the bare minimum. Not only does this give you a little extra room to maneuver, but it also encourages you to get rid of any unnecessary clutter, reducing potential airflow problems, or creating turbulent hotspots.

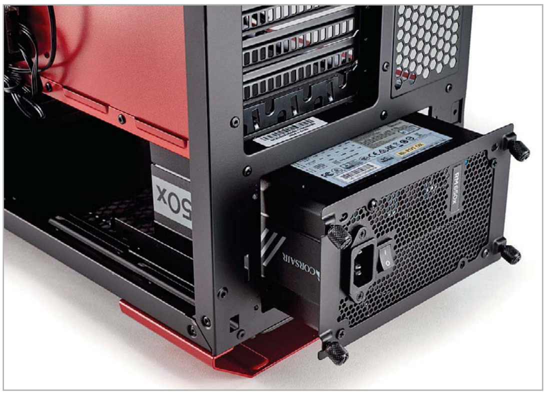
Tempered glass and acrylic windowed panels are best placed in the cardboard box, slotted between the polystyrene to keep them protected. Most cases are relatively simple to take apart, but the 5t is another story. There's a plethora of screws attaching the top panel to the chassis itself, all of varying shapes and sizes. As pictured, there's also a radiator/fan mounting panel, held down by four retainable thumbscrews.



2 INSTALL THE POWER SUPPLY

AHH, THE BEAUTY of a modular power supply! Corsair's RM series power supplies are a pretty affordable way of sprucing up any system. Although generally slightly longer than their non-modular cousins, being able to remove unnecessary cables from any build tends to make your life a lot easier.

With the MasterCase Maker 5t, the rear power supply bracket can be installed prior to sliding the power supply itself into the back of the case. Simply unscrew the four thumbscrews holding the bracket to the chassis, then use the included power supply screws to mount the bracket to the rear of the PSU. Make sure the fan is facing down, because the 5t lacks any top-sided ventilation, then simply slide the power supply into the back of the case, and secure it using the four thumbscrews once more.



3

REPLACE STOCK FANS

ALTHOUGH NOT AN ABSOLUTE NECESSITY, replacing the stock fans in any chassis with something a touch more premium helps improve overall performance. As standard, the 5t comes with three black Cooler Master 140mm fans—we've replaced them with three EK Vardar 120mm fans, to reduce noise and improve airflow and static pressure.

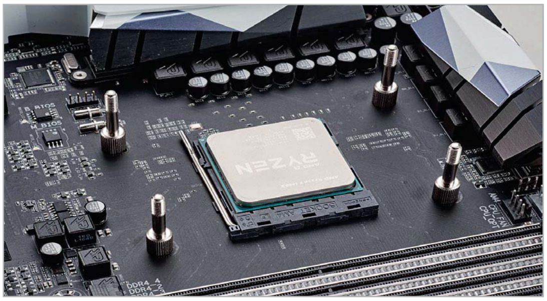
The original plan was to have the two Vardars at the front of the chassis, drawing air into the case, one exhausting out of the rear, then to use the AIO EK Predator, exhausting out of the roof, running in a slightly negative configuration. By the end of the build, our original plan had changed quite drastically, due to the limitations of the case itself—we talk about that more in our AIO section below, and in the conclusion.

4

INSTALL RYZEN AND AIO PREP

TRADITIONALLY, installing LGA processors tends to be a bit of a nightmare—there's plenty of opportunity to bend those delicate motherboard pins, which can ultimately kill your trusty build. With PGA processors, on the other hand, it's a far less dangerous business. Simply lift the retention arm up, match the golden triangle on the corner of the processor to the triangle on the socket, and carefully slot the processor into place. Wiggle it a bit, make sure it's snug and secure, with each pin in each hole, then lower the retention arm back into place.

Needless to say, this can be done when the motherboard is outside the case, and it's also the ideal time to install your AIO's backplate to the motherboard. For this particular cooler, you need to unscrew the default AMD bracket, align the EK backplate with rubber mounting in between, then thread the correct screws through it to lock it into place.

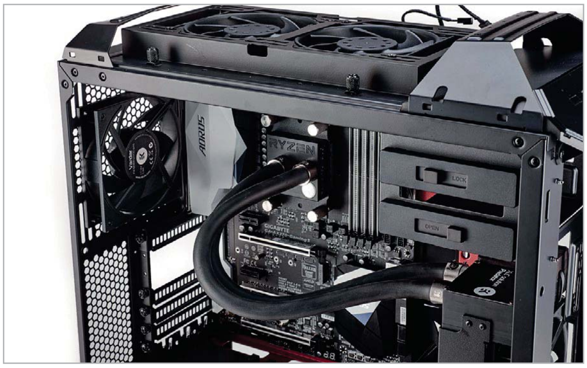


5

MOBO AND AIO INSTALLATION

NEXT UP, YOU'LL WANT to install the motherboard into the case. Lay the chassis down on its side, install the rear I/O plate, making sure to orient it correctly, then screw the motherboard into the stand-offs at all available screw holes. With a case like the 5t, you need to add the stand-offs yourself, depending on the size of the motherboard you're using.

This is where things got interesting for us. Due to a lack of clearances in the roof, we couldn't mount the EK Predator up above. After much shuffling, we opted to take the two 10TB HDDs out of the chassis, remove the HDD cage from the case, and install the Predator there, with the fans exhausting out of the front of the chassis. To mount the EK, simply apply a smidge of thermal paste to the center of the processor, place the four springs on each mounting screw, gently line the block over the top of the screws until it slides down over the processor, then screw the AIO down with the included thumbscrews.

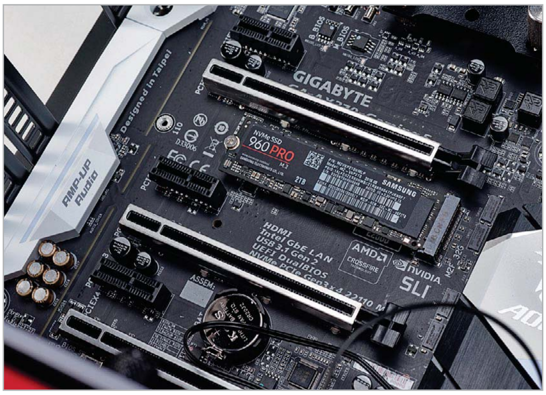


6

ADD THE PCIE M.2 SSD

GOING FROM AN SSD TO A PCIE SSD is the equivalent of going from an old-school hard drive to an SSD for the first time. The extra speed, although not particularly noticeable on startup, is astronomical on desktop. Copying and transferring files around a PCIe SSD such as Samsung's 960 Pro is almost instant for anything less than 5GB.

Installation couldn't be easier, either. Locate the M.2 port on your board, find the screw opposite the port, and undo the tiny screw on the top of the mounting point. Next, make sure the stand-off is in the correct position for the size of M.2 SSD you have. If it's in the wrong place, use a pair of needle-nose pliers to undo it, and screw it into the correct position. Then line your SSD up with the notch on both the stick and the connection, and slot it into place, before securing it with the M.2 screw.



7

GPU AND MEMORY

ALMOST AT THE END NOW. To install your graphics card, remove the two PCIe covers in the back of the chassis, where your card is going to slot in. These probably have two thumbscrews holding them in place. Then, lining the graphics card up with the slot, and with the rear I/O pointing to the back of the case, gently slot it into place until you hear a click. Then use those same thumbscrews that you removed earlier to secure the graphics card in place.

It's a very similar affair for memory. Make sure you match the off-center notch on the stick with the board, lift the two clips either side of the memory slot, and gently slide the stick of RAM into place until you hear the two clips lock into place. Use the correct color coded slots if using only two sticks.

GEFORCE GTX
AORUS

8

MORE LIGHTING

ONCE YOU'VE FINISHED CABLING up your system, and have routed everything out of the way (following the manual for front I/O headers), you'll want to deal with lighting—or maybe not, depending on your point of view. For us, it's part of what makes a system pop in a windowed chassis.

There's plenty of LED lighting in the MasterCase Maker 5t already, with a long strip located on the PSU cover, and our Aorus is littered with the stuff. We would have loved to have thrown a couple of extra white LED strips in the roof, and along the back or front, to really bring attention to that white motherboard, perhaps even disabling that red bar at the bottom, so as not to swamp out the white color theme in a murky shade of rouge.

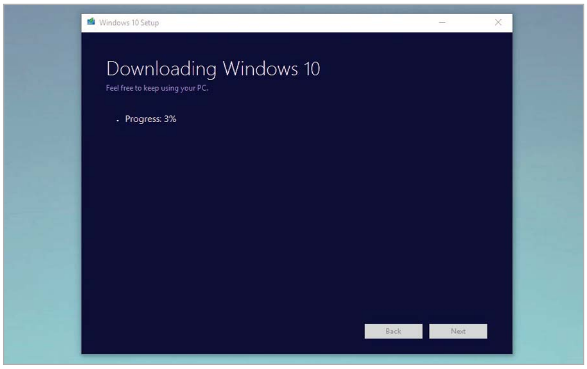
GEFORCE GTX

9

MIGRATE A WINDOWS INSTALL

SO, YOU'VE GOT FRESH HARD DRIVES, everything's ready to go, the system's powering on, everything's spinning, and you're not getting any memory issues. What next? You'll want to install your OS. For us, that's Windows 10's Technical Preview. Ahead of time, utilizing a laptop or your old system, you need to take an 8GB memory stick of some description, back up the documents on it elsewhere, and download the Windows Media Creation Tool from http://bit.ly/Win10MediaTool. Run the program, tell it you want to "Create installation media for another PC," choose which version you want to create a USB installer for, hit "Next," then point it at your USB stick.

The tool then downloads the OS and creates a bootable USB stick, ready for your install. If you're migrating a build, now is a good time to find your activation key, either in an email, if you bought your install direct from Microsoft, or on your last Windows CD.



Windows 10 Setup

Downloading Windows 10

Feel free to keep using your PC.

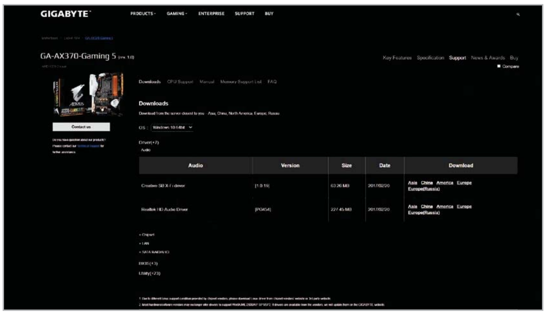
- Progress: 3%

10

INSTALL THE OS AND DRIVERS

PLUG THE USB STICK into your new machine. Power on your PC, and hammer that Delete key to get into the BIOS. Head to the "Boot" menu, and make sure "UEFI [insert name of USB stick]" is your first boot option. Then hit F10, save, and exit, and wait for the Windows installer to boot up. Go through the Windows setup option. Don't worry when it asks you for your activation key—you can skip this until later if you don't have it immediately available. Choose which drive you wish to install the OS on (ideally your M.2 PCIe SSD), let it install, and then once it restarts, pull the USB stick out. Windows then gives you the usual privacy invading options (we suggest switching them all off), and asks you to sign in or create a Microsoft account, which you can skip.

With the Aorus, you need to install the appropriate network and chipset drivers. Head to Gigabyte's website, search for your mobo, and download the latest versions under "Support." Then Google "AMD Ryzen drivers," click the top link, and download the latest AM4 chipset drivers.



GA-AX370-Gaming 5 (rev. 1.0)

Downloads

OS : Windows 10 64bit

Driver(+7)

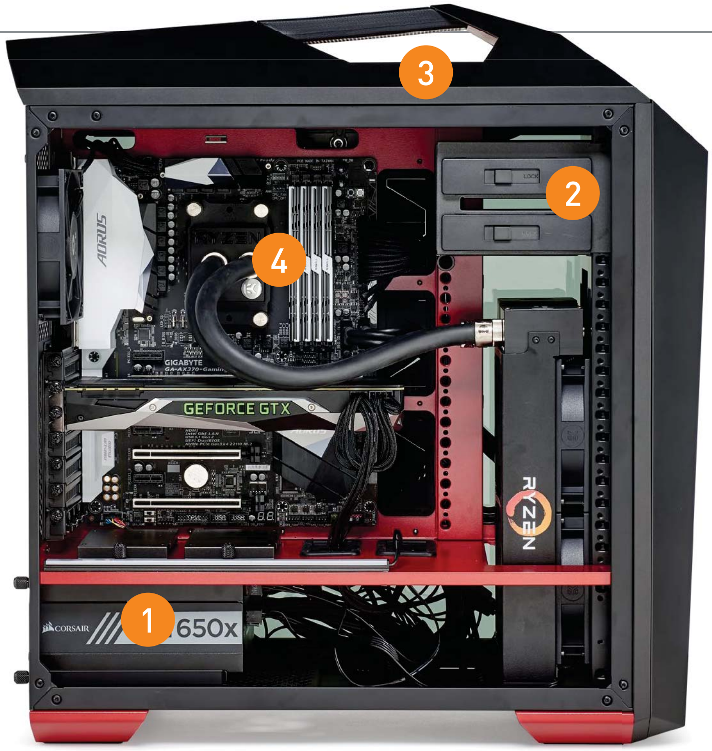
Audio

Audio	Version	Size	Date	Download
Creative SB X-Fi driver	(1.0.19)	63.26 MB	2017/02/20	Asia China America Europe Europe(Russia)
Realtek HD Audio Driver	(PG454)	227.45 MB	2017/02/20	Asia China America Europe Europe(Russia)

+ Chipset
+ LAN
+ SATA RAID/AHCI

BIOS(+3)

Utility(+23)



① A 650W power supply may seem a little lackluster for this build, but you can't really justify using more than a 700W power supply nowadays outside of multi-GPU setups and HEDT rigs.

② This 5.25-inch front bay really did get on our nerves. Unfortunately, it's pop riveted into the chassis, and isn't removable—another disadvantage of the MasterCase Maker 5t.

③ The carrying handle at the top may look a little garish, but it does make it slightly easier to lug about than its competitors.

④ The biggest disappointment on this build was being unable to get the memory to clock any higher than 2,133. Hopefully, Gigabyte will release more BIOS updates soon to improve memory compatibility.

RYZING TO THE CHALLENGE

FRUSTRATING IS THE WORD with this one. AIO woes cut our enjoyment short midway through the build. Having to install our AIO in the front, because it was half an inch longer than the top mounting tray, was pure frustration, especially as the mobo and fans were already installed. On top of that, the fact that the front is now an exhaust goes against most common airflow conventions. It is possible to rotate the fans, but you need a particular set of hex keys that we didn't have to hand. To compensate for this lack of positive pressure, we installed all three remaining fans (two in the roof and one in the rear) to draw into the chassis instead. Combined with the blower fan, it should lead to a mostly balanced system, and we've yet to see any temperature anomalies.

To combat our hardware predicaments, we opted for an external NAS. The 2TB of applicable solid-state storage should be enough for any short-term content creation and file transfers, and the 20TB of HDD storage in the WD My Cloud Ex 2 Ultra should provide suitable backup for all long-term projects.

Having the PSU on rails, however, was a dream. Midway through the build, we decided to swap the stock cables for a set of black braided ones, and it was simply a case of pulling the PSU out, swapping the cables round, threading them through, and sliding it back into the chassis.

But what about performance? We decided to slap a 4GHz overclock on all eight cores, to give the processor a little extra grunt in rendering tasks and single-core IPC. What was disappointing was the memory overclocking. We struggled to get the memory to clock at 2,400MT/s, being forced to leave it at stock. Regardless of what timings we tinkered with, voltages we applied, or memory profiles, the Gigabyte X370 didn't want to connect the dots.

As you'd expect, though, rendering performance was staggering, with nearly 1,700 points in Cinebench R15 multi-thread, and a solid 152 in single-thread. Backed up by 64GB of DDR4 and a 2TB PCIe SSD, it's not hard to imagine this thing flying when rendering everyday tasks.

And gaming? Well, that was a mixed bag of potatoes. AMD is still clearly having issues with a few titles, our *Total War: Attila* being the most telling, scoring just 36.2fps at 1080p. It's an aggressive title, no doubt, but when you consider that a few issues ago an Intel Pentium G4600 and GTX 1060 trumped this setup by a frame, it shows that optimizations need to be made. Whether that's on the OS or on AMD's side for chipset, it makes little difference to us.

Ultimately, Ryzen is a monster when it comes to professional workloads, board manufacturers still have to get up to par with memory compatibility, and gaming performance at lower resolutions could do with a tweak. But, bang for buck, it's damn near perfect, and will hopefully elicit a powerful response from Intel, too.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread (Index)	923	1,697 (84%)
Cinebench R15 Single-Thread (Index)	179	152 (-15%)
CrystalDisk QD32 Sequential Read (MB/s)	1,895	3,352 (77%)
CrystalDisk QD32 Sequential Write (MB/s)	949	1,861 (96%)
Total War: Attila (fps)	43	36 (-16%)
Rise of the Tomb Raider (fps)	67	89 (33%)
Far Cry Primal (fps)	105	85 (-19%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

AMD Ryzen 7 1800X
AMD
RYZEN
YD180XBCM88AE
UA 1705SUT
9GU3919N70009
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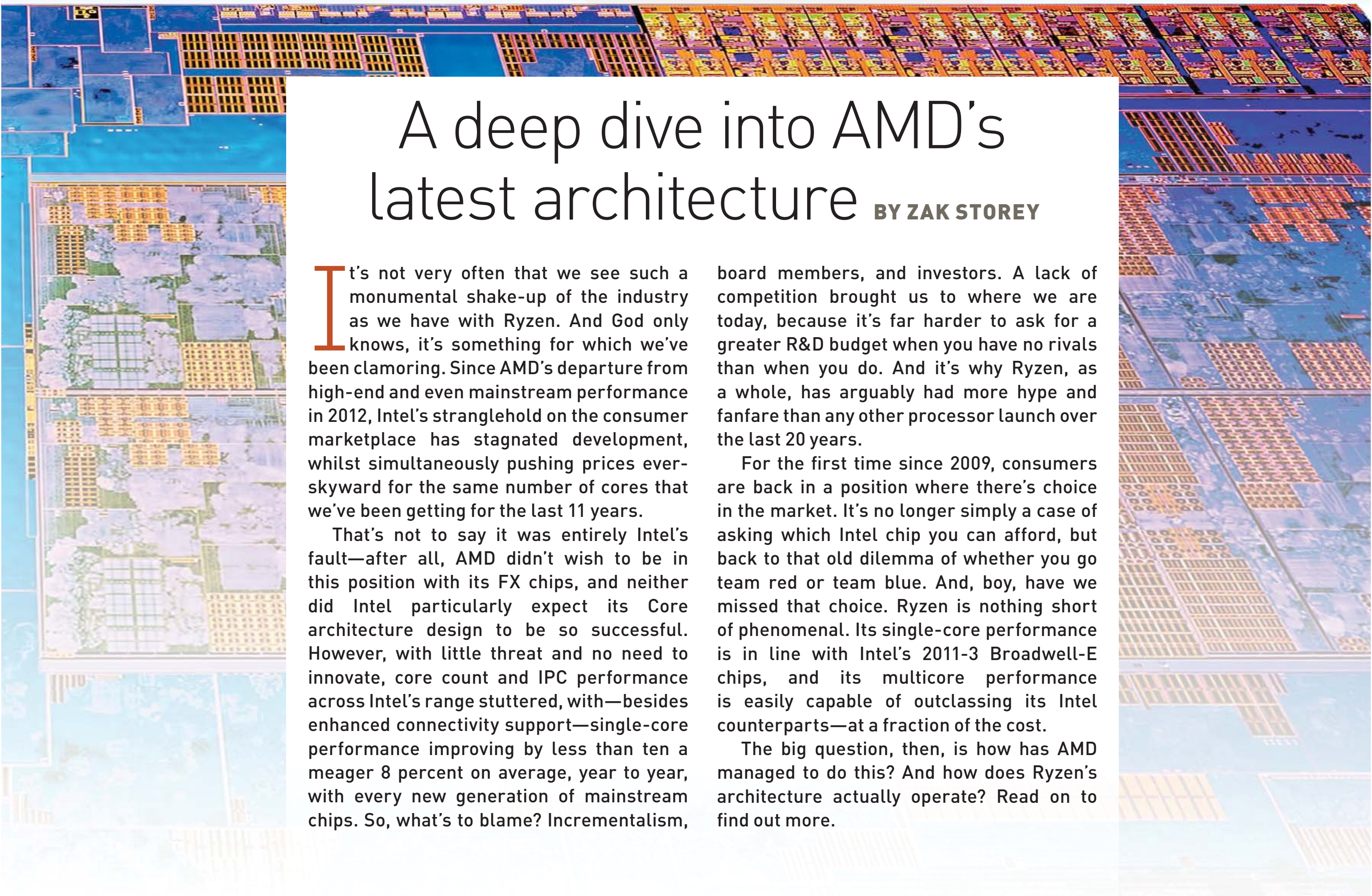
AMD's New Horyzen



A deep dive into AMD's latest architecture

BY ZAK STOREY

It's not very often that we see such a monumental shake-up of the industry as we have with Ryzen. And God only knows, it's something for which we've been clamoring. Since AMD's departure from high-end and even mainstream performance in 2012, Intel's stranglehold on the consumer marketplace has stagnated development, whilst simultaneously pushing prices ever-skyward for the same number of cores that we've been getting for the last 11 years.

That's not to say it was entirely Intel's fault—after all, AMD didn't wish to be in this position with its FX chips, and neither did Intel particularly expect its Core architecture design to be so successful. However, with little threat and no need to innovate, core count and IPC performance across Intel's range stuttered, with—besides enhanced connectivity support—single-core performance improving by less than ten a meager 8 percent on average, year to year, with every new generation of mainstream chips. So, what's to blame? Incrementalism, board members, and investors. A lack of competition brought us to where we are today, because it's far harder to ask for a greater R&D budget when you have no rivals than when you do. And it's why Ryzen, as a whole, has arguably had more hype and fanfare than any other processor launch over the last 20 years.

For the first time since 2009, consumers are back in a position where there's choice in the market. It's no longer simply a case of asking which Intel chip you can afford, but back to that old dilemma of whether you go team red or team blue. And, boy, have we missed that choice. Ryzen is nothing short of phenomenal. Its single-core performance is in line with Intel's 2011-3 Broadwell-E chips, and its multicore performance is easily capable of outclassing its Intel counterparts—at a fraction of the cost.

The big question, then, is how has AMD managed to do this? And how does Ryzen's architecture actually operate? Read on to find out more.

The Ryzen Line-Up

Let's cover the basics: What processors are going to be available under AMD's new architecture?

RYZEN 3

Due to be released during the second half of this year are AMD's "budget" chips—relatively speaking, of course. Expecting to come in four-core variants, these low-power processors should be aimed at office workstations and HTPCs, with budget gaming also on the cards. Note: The figures below are entirely speculative.

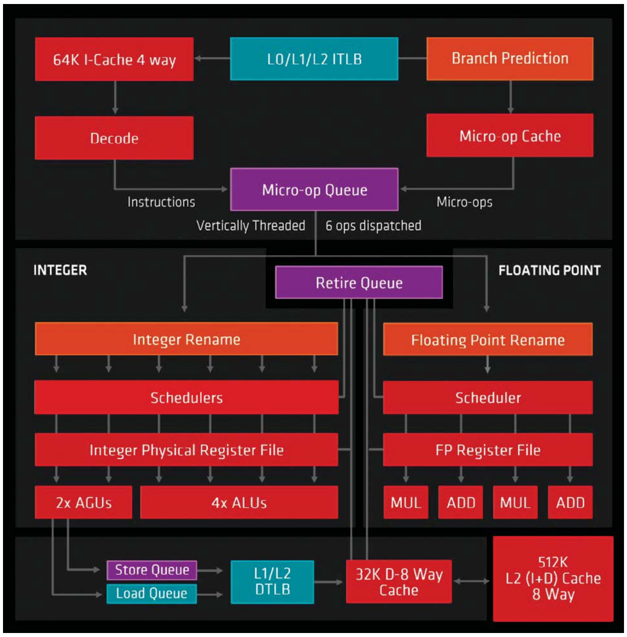
	Ryzen 3 1300	**Ryzen 3 1400X**
Cores	4	4
Threads	4	4
Frequency	3.2GHz–3.5GHz	3.4GHz–3.8GHz
TDP	45W	65W
Cost	$90	$120

RYZEN 5

It's hard to miss the fact that Ryzen's 5 series of processor is aiming its sights directly at the Intel Core i5 market. With its top-end chip topping out at six cores, 12 threads, and a whole whack of cache, this should be a good choice for any mainstream gamer going forward. And with AMD tactically holding these cores back until sufficient OS optimization has occurred, it means those after a competitive gaming chip should see some solid performance, as opposed to the fragmented 1080p performance experienced by Ryzen 7.

	Ryzen 5 1400	**Ryzen 5 1500X**	**Ryzen 5 1600**	**Ryzen 5 1600X**
Cores	4	4	6	6
Threads	8	8	12	12
Frequency	3.2GHz–3.4GHz	3.5GHz–3.7GHz	3.2GHz–3.6GHz	3.6GHz–4.0GHz
TDP	65W	65W	65W	95W
Cost	$170	$190	$220	$250

Understanding Processors

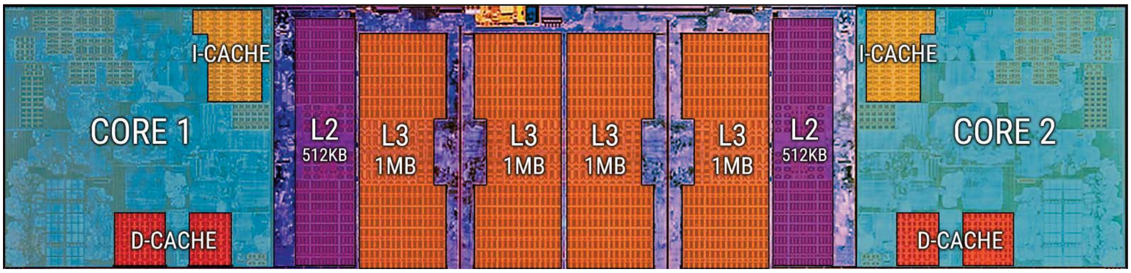

64K I-Cache 4 way
L0/L1/L2 ITLB
Branch Prediction
Decode
Micro-op Cache
Micro-op Queue
Instructions
Micro-ops
Vertically Threaded
6 ops dispatched
INTEGER
Retire Queue
FLOATING POINT
Integer Rename
Floating Point Rename
Schedulers
Scheduler
Integer Physical Register File
FP Register File
2x AGUs
4x ALUs
MUL
ADD
MUL
ADD
Store Queue
Load Queue
L1/L2 DTLB
32K D-8 Way Cache
512K L2 (I+D) Cache 8 Way

But what does all that mean? How do processors work? That's what we're going to attempt to cover in brief here.

Now, before we get into AMD's answer to Intel's Hyper-Threading, we need to understand exactly how calculations and data are processed via the CPU. Generally speaking, software asks a series of complex questions, one at a time, (known as the program order), which traditionally the processor then calculates, one after the other in serial. However, because processors calculate problems far faster than they can draw data from DDR, SSDs, or hard drives, this can lead to delays, as data strings may not always be located on the processor's cache, but somewhere else in the system.

Traditionally, it would go something like this: Calculation A provides answer B, which is used in calculation C, with data D drawn from DRAM, after which calculation E occurs. However, because we're waiting on data D, we're essentially stalling the unit, by not utilizing those execution units at 100-percent load.

Out-of-order execution (OoOE) looks to rectify this by determining which instructions require data that's stored in memory, establishing how long it will take to retrieve said data, then reordering the instructions so that instead of running in the original program order, it runs dependent on the availability of data. So, in our



A cross-section of a Ryzen four-core block. You can spot the L1 cache inside each core, and the L2 and L3 externally.

RYZEN 7

We've covered Ryzen's launch line of octo-core mainstream processors at length already. These eight-core, multithreaded rendering titans smash the competition on price to performance, although the chipset is somewhat weaker than both Z270 and X99 in comparison. Ryzen 7 has revolutionized the marketplace for the better—whether you're team red or blue, it's hard to deny just how huge a difference these chips are going to make.

	Ryzen 7 1700	Ryzen 7 1700X	Ryzen 7 1800X
Cores	8	8	8
Threads	16	16	16
Frequency	3.0GHz–3.7GHz	3.4GHz–3.8GHz	3.6GHz–4.0GHz
TDP	65W	95W	95W
Cost	$320	$400	$500

ARCHITECTURE DESIGN

Down to the nitty-gritty. What makes Ryzen tick? How does it work? What's new? And what can users look forward to in the future? Back in 2011, AMD realized it was on the back foot with chip design, so it went back to the drawing board, drafting in the legendary Jim Keller to set out the groundwork for the chip's architecture.

CORE DESIGN

Analyzing the Ryzen 7 1800X, we can split it down on a core by core basis. Each Ryzen 7 CPU comes with eight cores in total. Each core comes with 32KB of D-cache (where the CPU stores data string load and store requests after processing), and 64KB of I-cache (where the CPU stores its instructions drawn from programs), commonly known together as the L1 cache. Additionally, each core has a block of 512KB of slightly slower L2 cache, which can be used to store both data and instruction sets simultaneously. On top of that, each core has four integer units, with 42 registers apiece, six schedulers, four ALUs, and two AGUs. Separate from the Integer Units, there are also two Floating Point Units, 72 out-of-order load supports, and, of course, two threads per core. Scale that up, and each block of four cores has a shared L3 cache of 8MB apiece, leading to a combined total of 16MB of L3 cache, and 4MB of L1/L2 cache for each and every eight-core processor—plus, of course, 16 threads via AMD's SMT.

scenario, it would go like this: Calculation E is first, followed by calculation A, followed by calculation C, and by the time calculation C begins, hopefully enough clock cycles have passed for the processor to draw that absent data into the registers from the DRAM. The calculations that have been processed prior to the arrival of data D are held in what's known as a retire queue, and once the final calculation has been completed, are then reordered and output back to the program via the processor.

Branch prediction is the next step up from OoOE. This looks at each branch in a program's code, analyzes it, then tries to predict which unit each branch of instructions should be placed into.

Jargon Buster

AGU Address Generation Unit. Found in the Integer Unit, the AGUs calculate the addresses of data strings stored in system media, whether that be cache, DDR, SSD, HDDs, or any other media.

ALU Arithmetic Logic Unit. This is the part of a processor that calculates arithmetic and bitwise (binary) calculations, utilizing registers to do so.

Branch Found in programs, these are instructions that inform the processor to begin executing a different instruction sequence within a program.

Floating Point Unit Similar to the Integer Unit (see later), the Floating Point Unit performs calculations on floating point numbers, such as multiplications, divisions, square roots, and bit-shifting. These are split into separate execution units—in this case, two that deal with multiplication and two that deal with addition, with the rest of the less common calculations being dealt with on a software library level. The FPU is also known as an Execution Unit.

Integer Physical Register File Works in tandem with OoOE, withholding instructions from the execution units until they are needed.

Integer Unit The housing for both the ALUs and the AGUs. Also known as an Execution Unit.

Register Registers can hold both data and instructions, and are where a processor calculates a problem. For instance, an instruction set could be X + Y = Z, whilst the data would be the X and the Y. One register would hold the instruction, a second register holds the X, a third holds the Y, and lastly the result, Z, is held in a fourth, for further successive use in other calculations—or, if it's no longer needed, it's then pushed to the relevant cache for later use.

Simultaneous Multithreading and You

AMD Ryzen 7 1800X
AMD
RYZEN

SMT, although not new to the scene, has been dominated by Intel's Hyper-Threading—at least, until now

And so, we finally get to look at AMD's Simultaneous Multithreading. Although Intel was certainly the first to the consumer market with its iteration of simultaneous multithreading—Hyper-Threading—AMD's SMT operates in much the same way.

When most people think of a thread, they imagine it's not that dissimilar from a core. "It's the arm that feeds the core most often" is a phrase repeated readily online. In reality, a thread is actually smaller than a process (think Task Manager). In fact, it's defined as "the smallest sequence of programed instructions that can be managed independently by a scheduler." Traditionally, a core processes one thread at a time. However, each instruction within each thread has varying degrees of difficulty, and the time required to calculate each part of that thread can't just be solved by using things such as OoOE and Branch Prediction. So, Simultaneous Multithreading shares core resources between multiple threads—in this case, two simultaneously—and with a combination of algorithms and outright openly shared resources, allows the processor to allocate these two threads to be executed in tandem on the execution units that aren't currently being utilized.

This tricks the operating system into thinking the processor has two cores, instead of the physical one. With Ryzen, only three parts of each core are statically partitioned and unavailable to both threads simultaneously: the Retire Queue, where the instructions are sent, ready to be reordered after OoOE has had its way; the Store queue, where AGUs temporarily store memory address allocations; and the Micro-Op Queue, where the decoded instructions are fed into the IU and the FPUs. Everything else that we've previously discussed is available to both threads.

INTEGRATED I/O

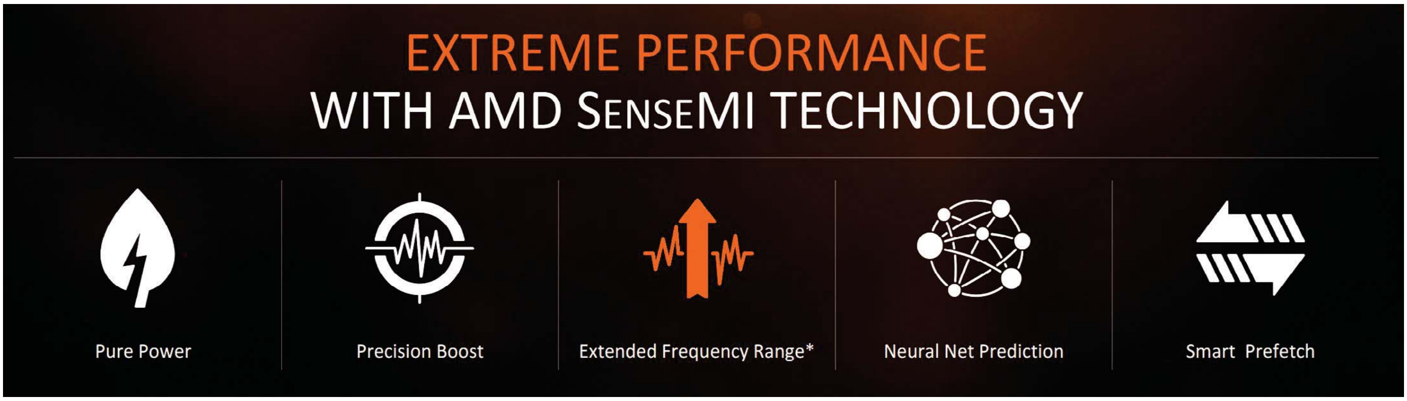
So, what's different this time around, compared to team blue? As far as we know, the vast majority of Ryzen CPUs feature a heavily integrated I/O on the chip itself. Unlike Intel, which only features 16 PCIe 3.0 lanes in its mainstream processors, of which all are dedicated to graphics solutions, Ryzen has a total of 20 PCIe 3.0 lanes. Still housing the same 16 dedicated to graphics, Ryzen has an additional four dedicated to what AMD has termed "general use"—in other words we're talking about PCIe NVMe SSDs.

In a way, this harks back to AMD's old philosophy of "update the processor not the motherboard." Because most of the I/O support is now on the chip itself, those not wanting to upgrade their motherboard over the next couple of generations need not worry, while newer generations of chips will hopefully support a greater number of direct connect I/Os.

Having the PCIe 3.0 lanes on the chip like that eliminates the chipset itself as the middleman, and allows all Ryzen processors to have unfettered access to any connected SATA or NVMe devices—likely the device providing the vast majority of program instructions to the processor. This reduces additional delays created by the intermediary chipset, and is a feature seen on Intel's HEDT Extreme Edition line-up of processors.

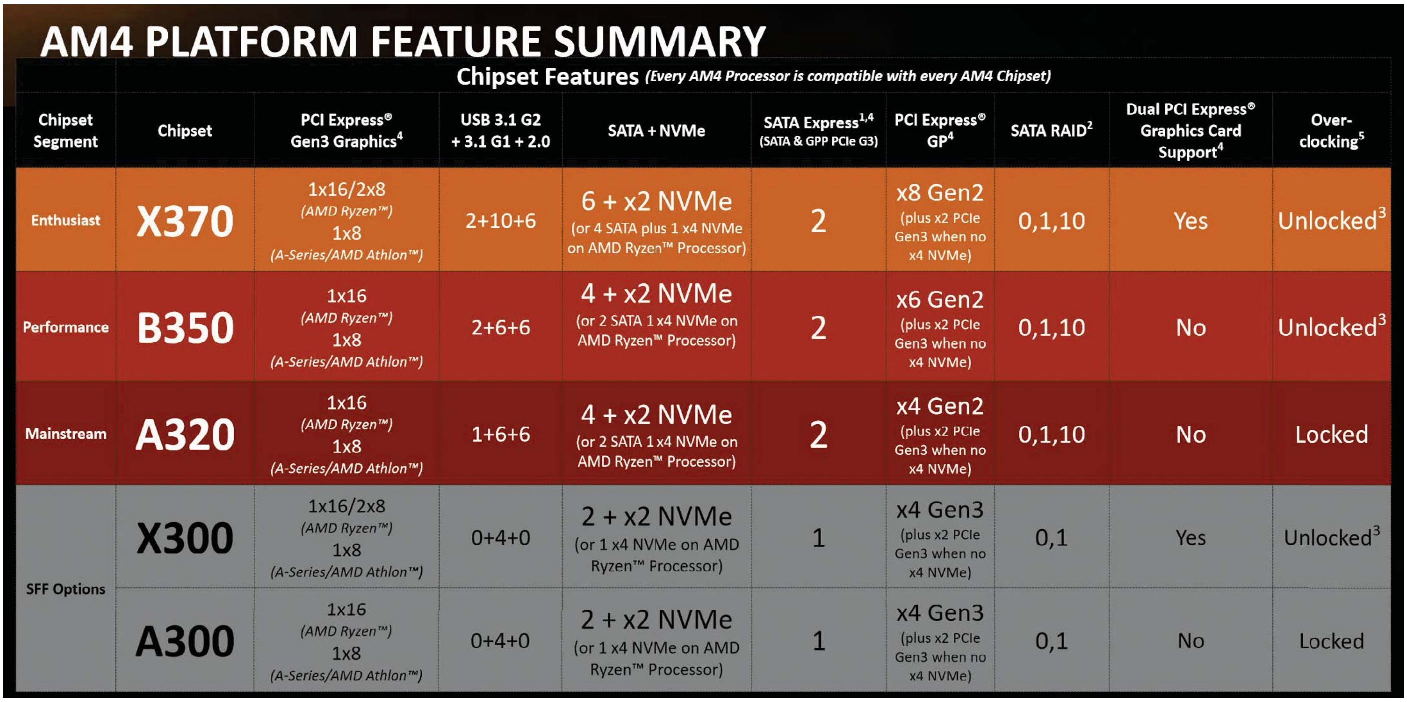
X370 CHIPSET

Now, that's not to say the X370 chipset isn't throwing its own punches. With native


EXTREME PERFORMANCE
WITH AMD SENSEMI TECHNOLOGY

Pure Power
Precision Boost
Extended Frequency Range*
Neural Net Prediction
Smart Prefetch

Each Ryzen processor is different, and SenseMi strives to fix that.



AM4 PLATFORM FEATURE SUMMARY

Chipset Features *(Every AM4 Processor is compatible with every AM4 Chipset)*

Chipset Segment	Chipset	PCI Express® Gen3 Graphics[4]	USB 3.1 G2 + 3.1 G1 + 2.0	SATA + NVMe	SATA Express[1,4] (SATA & GPP PCIe G3)	PCI Express® GP[4]	SATA RAID[2]	Dual PCI Express® Graphics Card Support[4]	Over-clocking[5]
Enthusiast	X370	1x16/2x8 *(AMD Ryzen™)* 1x8 *(A-Series/AMD Athlon™)*	2+10+6	6 + x2 NVMe (or 4 SATA plus 1 x4 NVMe on AMD Ryzen™ Processor)	2	x8 Gen2 (plus x2 PCIe Gen3 when no x4 NVMe)	0,1,10	Yes	Unlocked[3]
Performance	B350	1x16 *(AMD Ryzen™)* 1x8 *(A-Series/AMD Athlon™)*	2+6+6	4 + x2 NVMe (or 2 SATA 1 x4 NVMe on AMD Ryzen™ Processor)	2	x6 Gen2 (plus x2 PCIe Gen3 when no x4 NVMe)	0,1,10	No	Unlocked[3]
Mainstream	A320	1x16 *(AMD Ryzen™)* 1x8 *(A-Series/AMD Athlon™)*	1+6+6	4 + x2 NVMe (or 2 SATA 1 x4 NVMe on AMD Ryzen™ Processor)	2	x4 Gen2 (plus x2 PCIe Gen3 when no x4 NVMe)	0,1,10	No	Locked
SFF Options	X300	1x16/2x8 *(AMD Ryzen™)* 1x8 *(A-Series/AMD Athlon™)*	0+4+0	2 + x2 NVMe (or 1 x4 NVMe on AMD Ryzen™ Processor)	1	x4 Gen3 (plus x2 PCIe Gen3 when no x4 NVMe)	0,1	Yes	Unlocked[3]
	A300	1x16 *(AMD Ryzen™)* 1x8 *(A-Series/AMD Athlon™)*	0+4+0	2 + x2 NVMe (or 1 x4 NVMe on AMD Ryzen™ Processor)	1	x4 Gen3 (plus x2 PCIe Gen3 when no x4 NVMe)	0,1	No	Locked

All the AM4 chipsets. Note: X300 and A300 chipsets, supporting ITX, will be released later this year.

support for USB 3.1, support for six USB 3.0 devices, six USB 2.0 devices, four SATA 6Gb/s, and an additional four SATA 6Gb/s or two SATA Express, there's plenty on board to keep up with the latest innovations hitting mainstream storage, and to keep enthusiast builders happy. And, of course, that doesn't include any support added by third-party chipset manufacturers.

Is it as inclusive as Intel's Z270 or X99 chipsets? No. Does it lack RAID 0/1 M.2 PCIe support? Yes. But, to be honest, these are minor niggles, and for the vast majority of people—even power users—it's likely to matter very little.

SENSEMI SUITE

SenseMi is AMD's latest optimization package, developed at a software level to take advantage of the Ryzen processors. It's made up of five separate parts: Pure Power, Precision Boost, XFR, Neural Net Prediction, and Smart Prefetch.

• Pure Power

Pure Power is an advanced form of power and temperature monitoring software. Each Ryzen processor has around 1,000 sensors embedded across each chip, capable of detecting temperature and millivolt variances to an accuracy of one unit. This allows Ryzen, through learning algorithms, to adjust both frequency and voltages across the chip to efficiently lower power draw, without affecting performance.

This sounds overly complex, but it has been put in place largely to mitigate the effects of the silicon lottery. Because every chip has its own unique characteristics, Pure Power can identify any potential problems, and work around them to deliver identical performance, with stronger power savings overall.

• Precision Boost

Think of Precision Boost as a smarter form of Intel's Turbo technology. Unlike Intel's 100MHz increments, AMD has a total of 100 25MHz increments across its range, allowing for smart use of all eight cores, depending on workload, and in more granular increases than the competition, which improves stability. If we take the Ryzen 7 1800X, if only two cores are being used fully, Precision Boost bumps these two cores up to 4GHz—however, anything more than that, and it boosts all of the cores from its base frequency of 3.6GHz up to 3.7GHz.

> Is it as inclusive as Intel's Z270 or X99 chipsets? No. Does it lack RAID 0/1 M.2 support? Yes, but these are minor niggles.

• XFR (or Extended Frequency Range)

XFR is a further advancement of the Precision Boost software. However, it is based entirely on cooling, as opposed to utilization. If the processor detects that its temperatures remain below certain levels under load, it can auto overclock itself by an additional 100MHz across multiple cores. This works with air towers and AIO coolers, and increases the overall maximum clock speed by 100MHz, both at the full eight-core complement (boosting it up to 3.8GHz) and when two cores are being utilized (boosting up to 4.1GHz).

• Neural Net Prediction

According to AMD, Neural Net Prediction is a "true artificial network inside every Zen processor." In short, it's supposed to build a model of the decisions driven by software code execution, anticipate future decisions, and preload instructions. So, hypothetically, the more you run a certain program, the better it will operate. Whether that's true or not is difficult to tell at this point in time.

• Smart Prefetch

Smart Prefetch is in a very similar vein as Neural Net Prediction, anticipating the location of future data accesses by application code. Sophisticated learning algorithms model and learn application data access patterns, and prefetch vital data into the local cache, so it's ready for immediate use. Once again, this is something that will develop over time and with regular use.

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50 HIDDEN SECRETS OF WINDOWS 10

Delve deep into the hidden recesses of Windows with the help of *Nick Peers*

You can spend—and may already have spent—a lifetime trying to master Windows. Just when you get to grips with one version, out comes another. These days, things are further complicated by the fact that while Windows 10 seems here to stay, it's now undergoing more frequent changes, with a succession of major updates: Anniversary last year, Creator last month, and another (Windows 10.3, anyone?) slated for the end of the year. How do you possibly keep up?

The trick is to realize that the more things change, the more they stay the same, with many of the best tips and tricks that were uncovered during those halcyon days of Windows XP and 7 still relevant now. The problem is, where to find them?

That's what's driven us to write this feature. We've gone hunting for 50 of the most obscure—but nevertheless useful—tips we can find. We've rooted out new techniques for old favorites, and also uncovered some new features that may not have made the headlines when the Creator's Update appeared, but will still help improve the way you use Windows. One of the joys of researching and writing this kind of feature is uncovering secrets that we—the so-called experts—weren't aware of. You know you're on the right track when you stumble upon tips that save you time and prove useful to your own computing life, and more than a few of those revealed themselves.

We're confident that you'll find at least one tip in this collection that will transform the way you use your PC. But mindful of providing value for money, we've decided 50 isn't enough. You'll find three additional boxes scattered through the feature, each one revealing bonus secrets you can use to save time and speed up the way you use your PC. We discover how to quickly access system settings without wading through menus and dialog boxes, we uncover some Registry shortcuts that enable you to change the way Windows looks and behaves, and we finish off by revealing lesser known—but still immensely useful—keyboard shortcuts.

Ready? Dust down your fedora, Dr Jones, we're going on a treasure hunt.

1

CUSTOMIZE "QUICK LINK" MENU

Add your own custom shortcuts to the menu that appears when you right-click the "Start" button. Use the portable Win+X Menu Editor tool (http://winaero.com/comment.php?comment.news.30) to add programs, control panel applets, and other system shortcuts, plus organize them all into groups.

2

CREATE GODMODE

Create a new folder and name it as shown below (you can change the "GodMode" part if you like):
GodMode.{ED7BA470-8E54-465E-825C-99712043E01C}
This gives you easy access to every single control panel applet via a convenient list—why not add it to your "Quick Link" menu?

3

VIEW USAGE BY DRIVE

Windows 10 provides you with a handy way of seeing what kind of content is taking up space on each of your drives. Navigate to "Settings → System → Storage," and tap a drive to see a breakdown of content by type. The Creator's Update also introduces a "Storage Sense" button, which automatically clears temporary files, and files residing in the bin for over 30 days.

4

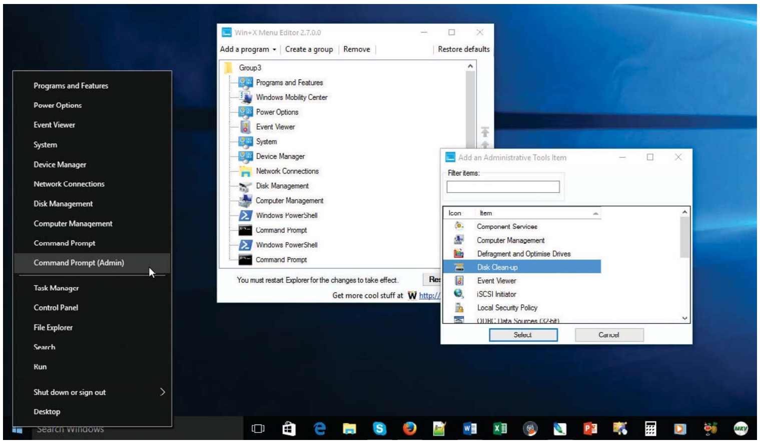
MOVE APPS TO ANOTHER DRIVE

Running out of space on your system drive? Move existing Windows Store apps to another drive or partition via "Settings → Apps"—select the app, and click "Move" to select your target drive. Force all new apps to install to a specified drive by switching to the "Storage" section, and tapping "Change where new content is saved."

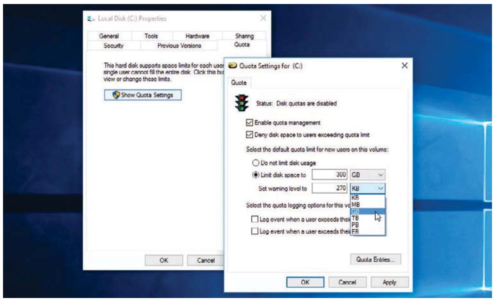
5

MOVE ANY PROGRAM

Why stop with Windows Store apps when you can move any installed desktop program? Download Steam Mover from www.traynier.com, and run it as an administrator. Point "Steam Apps Common Folder" to your Program Files folders, then select an alternative folder on your target drive (which must be formatted NTFS). Once done, select each program you wish to move, and click the right arrow button to move them across. Clever use of "Junction Points" ensure the programs continue to work even from another drive, and you can always move them back if needed.


Win+X Menu Editor 2.7.0.0
Add a program
Create a group
Remove
Restore defaults
Group3
Programs and Features
Windows Mobility Center
Power Options
Event Viewer
System
Device Manager
Network Connections
Disk Management
Computer Management
Windows PowerShell
Command Prompt
Windows PowerShell
Command Prompt
You must restart Explorer for the changes to take effect.
Get more cool stuff at
Add an Administrative Tools Item
Filter items:
Icon
Item
Component Services
Computer Management
Defragment and Optimise Drives
Disk Clean-up
Event Viewer
iSCSI Initiator
Local Security Policy
ODBC Data Sources (32-bit)
Select
Cancel
Programs and Features
Power Options
Event Viewer
System
Device Manager
Network Connections
Disk Management
Computer Management
Command Prompt
Command Prompt (Admin)
Task Manager
Control Panel
File Explorer
Search
Run
Shut down or sign out
Desktop
Search Windows

Place your own custom shortcuts on the "Quick Access" menu.


Local Disk (C:) Properties
General
Tools
Hardware
Sharing
Security
Previous Versions
Quota
Show Quota Settings
OK
Cancel
Quota Settings for (C:)
Quota
KB
MB
GB
TB
PB
EB
Quota Entries...
OK
Cancel
Apply

Status: Disk quotas are disabled

☑ Enable quota management

☑ Deny disk space to users exceeding quota limit

Select the default quota limit for new users on this volume:

○ Do not limit disk usage

● Limit disk space to 300 GB

Set warning level to 270 KB

Select the quota logging options for this vo

☐ Log event when a user exceeds thei

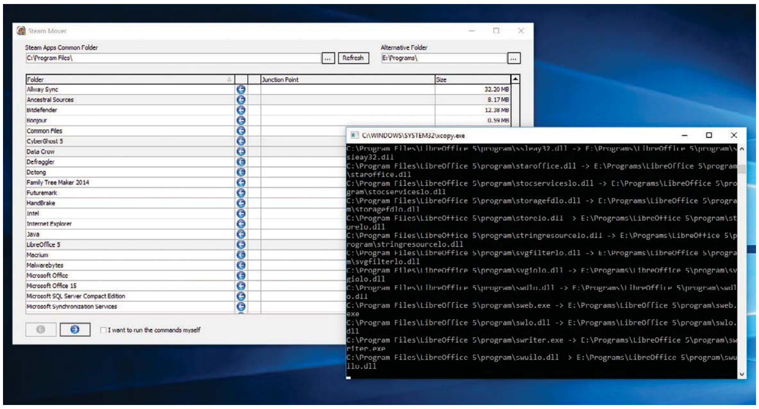
☐ Log event when a user exceeds thei

Stop users hogging space by setting drive quotas.

6

RESTRICT DRIVE USAGE

Prevent shared users from hogging all available drive space by setting up drive-based quotas (again NTFS-formatted drives only). Open "File Explorer → This PC," right-click your target drive, and choose the "Properties → Quota" tab. Click "Show Quota Settings," and check "Enable quota management," followed by "Deny disk space to users exceeding quota limit," and select "Limit disk space to." Set your limit (probably in GB) and a warning (say 10–20 percent less than the limit), then click "OK."


Steam Mover
Steam Apps Common Folder
C:\Program Files\
Refresh
Alternative Folder
E:\Programs\
Folder
Junction Point
Size
Allway Sync
Ancestral Sources
Bitdefender
Bonjour
Common Files
CyberGhost 5
Data Crow
Defraggler
Dctong
Family Tree Maker 2014
Futuremark
HandBrake
Intel
Internet Explorer
Java
LibreOffice 5
Macrium
Malwarebytes
Microsoft Office
Microsoft Office 15
Microsoft SQL Server Compact Edition
Microsoft Synchronization Services
32.20 MB
8.17 MB
12.38 MB
0.59 MB
I want to run the commands myself
C:\WINDOWS\SYSTEM32\xcopy.exe

```
C:\Program Files\LibreOffice 5\program\ssleay32.dll -> E:\Programs\LibreOffice 5\program\s
sleay32.dll
C:\Program Files\LibreOffice 5\program\staroffice.dll -> E:\Programs\LibreOffice 5\program
\staroffice.dll
C:\Program Files\LibreOffice 5\program\stocserviceslo.dll -> E:\Programs\LibreOffice 5\pro
gram\stocserviceslo.dll
C:\Program Files\LibreOffice 5\program\storagefdlo.dll -> E:\Programs\LibreOffice 5\progra
m\storagefdlo.dll
C:\Program Files\LibreOffice 5\program\storelo.dll -> E:\Programs\LibreOffice 5\program\st
orelo.dll
C:\Program Files\LibreOffice 5\program\stringresourcelo.dll -> E:\Programs\LibreOffice 5\p
rogram\stringresourcelo.dll
C:\Program Files\LibreOffice 5\program\svgfilterlo.dll -> E:\Programs\LibreOffice 5\progra
m\svgfilterlo.dll
C:\Program Files\LibreOffice 5\program\svgiolo.dll -> E:\Programs\LibreOffice 5\program\sv
giolo.dll
C:\Program Files\LibreOffice 5\program\swdlo.dll -> E:\Programs\LibreOffice 5\program\swdl
o.dll
C:\Program Files\LibreOffice 5\program\sweb.exe -> E:\Programs\LibreOffice 5\program\sweb.
exe
C:\Program Files\LibreOffice 5\program\swlo.dll -> E:\Programs\LibreOffice 5\program\swlo.
dll
C:\Program Files\LibreOffice 5\program\swriter.exe -> E:\Programs\LibreOffice 5\program\sw
riter.exe
C:\Program Files\LibreOffice 5\program\swuilo.dll -> E:\Programs\LibreOffice 5\program\swu
ilo.dll
```

Move any app to another drive using SteamMover.

7

RESTRICT USAGE ON PER-USER BASIS

To set limits for individual users, leave "Do not limit disk usage" selected, and click "Quota Entries" instead. Select "Quota → New Quota Entry." Click "Advanced," then "Find Now" to list all available users. Select a name from the list, and click "OK" twice. Set their quota and warning limits, then repeat for other users for whom you wish to apply limits. Once done, close the window, and click "OK" twice.

8

TAKE OWNERSHIP QUICKLY

Need to reclaim ownership of a file or folder? Add a convenient shortcut to the right-click menu: download www.howtogeek.com/wp-content/

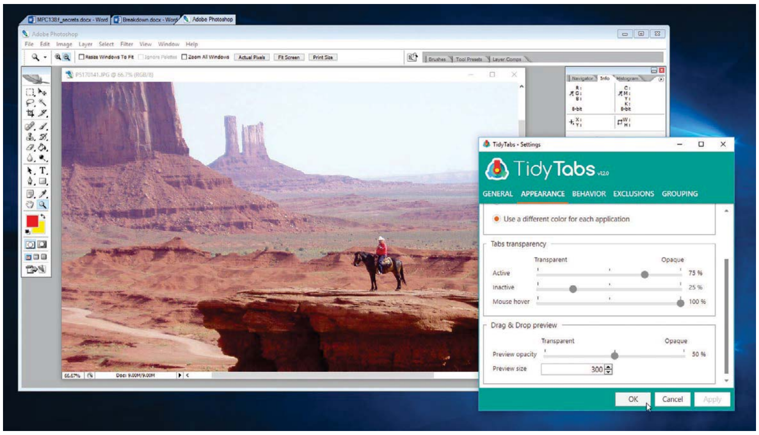
uploads/TakeOwnership.zip—open the zip file, and double-click "InstallTakeOwnership.reg," clicking "Run" followed by "Yes," "Yes," and finally "OK" when prompted. Now right-click any folder or file to find a new "Take Ownership" option.

9 TASK VIEW SHORTCUTS

Press Win-Tab to trigger Task View, where you can easily move windows between multiple virtual desktops. Press Ctrl-Win-D to quickly create (and switch to) a new virtual desktop, and Ctrl-Win-left/right cursor to move between them.

10 GROUP WINDOWS BY TAB

Task View too awkward? Download and install TidyTabs (www.nurgo-software.com/products/tidytabs), and you can group multiple windows together in a single tabbed window—just like your browser, except it covers all apps, and you can mix and match different programs, too.



● Use a different color for each application

Tabs transparency
Active 75 %
Inactive 25 %
Mouse hover 100 %

Drag & Drop preview
Preview opacity 50 %
Preview size 300

TidyTabs groups app windows into tabs, like your browser does.

11 SWITCH DEFAULT VIEW

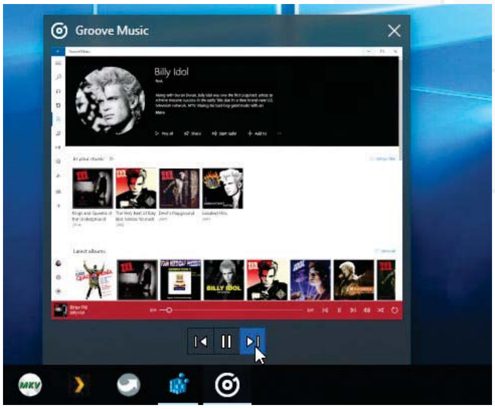
When you open a new File Explorer window, it defaults to the "Quick Access" menu. Change this by going to the "File" tab on the Explorer ribbon, and choosing "Folder & Search Options." Click "Open File Explorer to…" and choose "This PC" to change the default action to showing your user folders, drives, and network locations.

12 TWEAK "QUICK ACCESS" FOLDER

You can also customize the "Quick Access" folder from here, too, by selectively removing both recently used files and frequently accessed folders from its view if you wish—this leaves only those shortcut folders that you specifically pin to the menu.

13 BACKGROUND SCROLLING

This feature enables you to scroll any program window using your mouse or trackpad, by moving the cursor over it, even when it's not in focus. Toggle it on and off via the "Scroll inactive windows when I hover over them" switch under "Settings → Devices → Mouse and Touchpad."



Control playback from the Taskbar with Groove Music.

14 CONTROL FROM TASKBAR

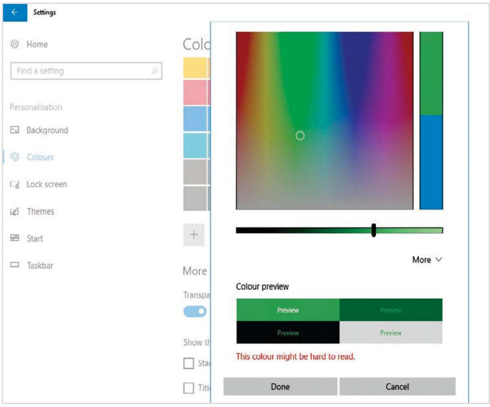
The Aero Peek feature provides you with a convenient way to preview open app and program windows, without bringing them into focus, but it can provide other shortcuts, too. Take the Groove Music app, for example—roll your mouse over its Taskbar icon, and the Aero Peek preview contains playback controls you can use without bringing the main program into focus.

15 SNAP APP WINDOWS

Snap Assist makes it even easier to snap multiple windows in place. Snap your first window in place by dragging it to the edge or corner of the screen, at which point all other windows appear as they do when in Task View. You can then drag these into place, bring them into focus, or even close them quickly and easily.

16 MORE COLOR CHOICES

The Creator's Update gives you more control over your color scheme when tweaking your desktop. Go to "Settings → Personalization → Colors," and click "Custom Color." Use the color picker to choose your color, then adjust it with the help of a slider and preview (complete with a warning, should the colors be difficult to read).



This colour might be hard to read.

Choose your own custom color scheme with the Creator's Update.

17

TWEAK NOTIFICATION SETTINGS

Fed up with certain apps constantly badgering you with notifications through the Action Center? Go to "Settings → System → Notifications & actions," then scroll down to pick and choose exactly what apps and services get to notify you.

18

REMEMBER, REMEMBER

If you frequently forget something within moments of thinking it, Cortana could prove to be your lifesaver. Simply type (or speak) "remember" to set up a reminder from scratch, or try something such as "remember to get milk tomorrow after work" to include additional details.

19

DISABLE CORTANA

The quickest way to disable Cortana (although the process itself still runs in the background) is via a security policy setting—open Registry Editor, browse to HKEY_LOCAL_MACHINE\SOFTWARE\Policies\Microsoft\Windows\WindowsSearch, and create a new DWORD value named "AllowCortana." Leave it set to 0, restart Windows Explorer via Task Manager, and it's disabled.

20

YOUR NEW SEARCH BOX

Once Cortana is disabled, the Search box displays "Search Windows," and you can continue to use it to find apps, settings, and files on your PC—tap "Filters" to choose specific things to search for, such as folders, documents, or music. (While we're on the subject, right-click the Taskbar, and choose "Search → Show search icon" to replace the Search box with a simple search button.)

21

MASTER FILE ASSOCIATIONS

The quickest way to change a single file type's association is to right-click a file in File Explorer, then choose "Open With → Choose another app." Be sure to select "Always use this app to open…" before going through the list to find your chosen app (if it's not displayed, click "More apps," then scroll down to the bottom, and click "Look for another app on this PC").

22

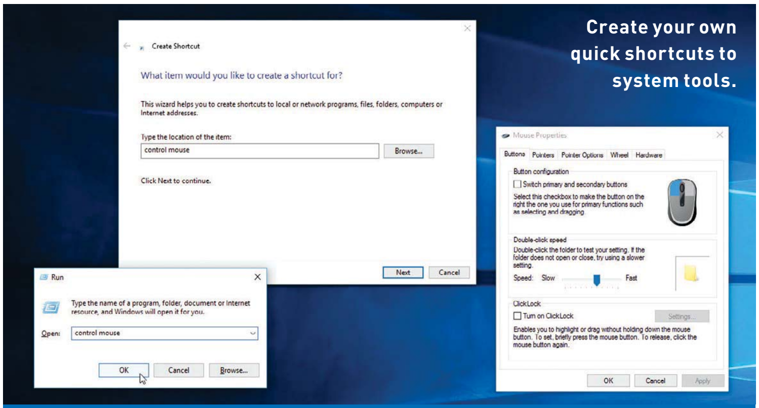
SWITCH DEFAULT PROGRAMS

There's little choice to be had at "Settings → Apps → Default apps," but scroll down and you can choose "Set defaults by app" to gain access to a much wider range of apps. Select one to quickly assign multiple file types to it via "Choose defaults for this program."

23

SAVE BANDWIDTH

There are many ways in which you can stop Windows wasting precious bandwidth when connected to a metered network, all accessible via Settings. First, go to "Update & Security → Windows



What item would you like to create a shortcut for?

This wizard helps you to create shortcuts to local or network programs, files, folders, computers or Internet addresses.

Type the location of the item: control mouse

Click Next to continue.

Type the name of a program, folder, document or Internet resource, and Windows will open it for you.

Open: control mouse

Button configuration

☐ Switch primary and secondary buttons

Select this checkbox to make the button on the right the one you use for primary functions such as selecting and dragging

Double-click speed

Double-click the folder to test your setting. If the folder does not open or close, try using a slower setting.

Speed: Slow Fast

ClickLock

☐ Turn on ClickLock

Enables you to highlight or drag without holding down the mouse button. To set, briefly press the mouse button. To release, click the mouse button again.

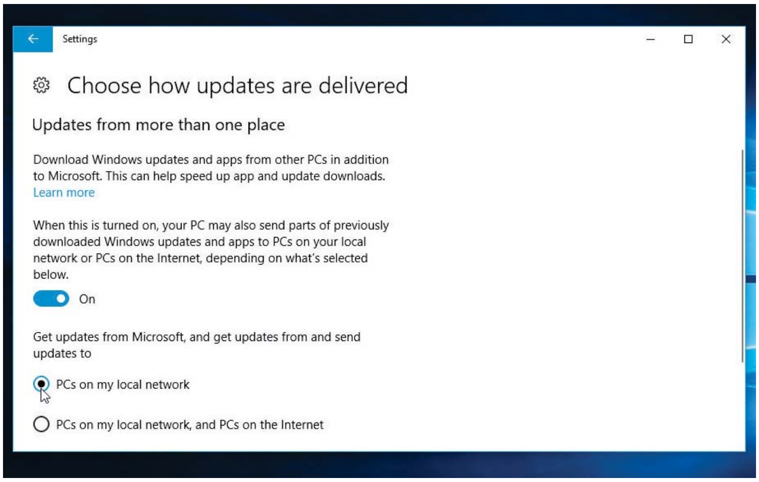
Create your own quick shortcuts to system tools.

Shortcuts to System Settings

Why go hunting for specific settings or control panel applets when—armed with the right shortcuts—you can jump straight to them? The following 11 shortcuts work when entered in the "Run" dialog box (press Win-R) or when creating a shortcut:

SHORTCUT	JUMPS TO
control appwiz.cpl	"Program and Features" control panel
control date/time	"Date and Time Properties" window
control desk.cpl	"Settings → System → Display"
control desk.cpl,,2	"Settings → Personalization"
control folders	"File Explorer Properties" window
control fonts	"Fonts" folder
control mouse	"Mouse Properties" control panel applet
control system	System Properties
control sysdm.cpl,,4	"System Protection" tab under System Properties
control printers	"Devices and Printers" control panel
control userpasswords2	Hidden "User Accounts" dialog

More examples can be found at www.lifewire.com/shortcuts-2626060, or you can add shortcuts directly to the "Quick Access" menu via Win+X Menu Editor's "Add a program → Add a Control Panel item" command.



Choose how updates are delivered

Updates from more than one place

Download Windows updates and apps from other PCs in addition to Microsoft. This can help speed up app and update downloads.
Learn more

When this is turned on, your PC may also send parts of previously downloaded Windows updates and apps to PCs on your local network or PCs on the Internet, depending on what's selected below.

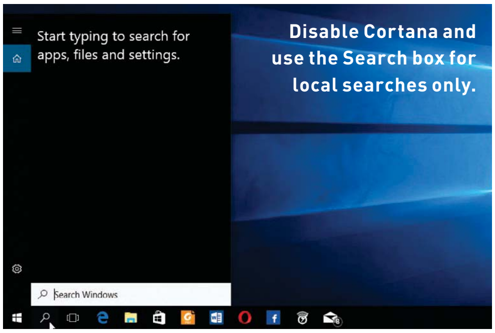
On

Get updates from Microsoft, and get updates from and send updates to

● PCs on my local network

○ PCs on my local network, and PCs on the Internet

Prevent your PC from sharing updates over the Internet.


Start typing to search for apps, files and settings.
Search Windows

Disable Cortana and use the Search box for local searches only.

Update → Advanced options → Choose how updates are delivered," and change it to "PCs on my local network," or even flick the switch off.

24

REDUCE DATA USAGE

Go to "Network & Internet → Wi-Fi," and click "Manage known networks." Choose a network with bandwidth limits, and click "Properties." Flick "Set as metered connection" to "On," then go to "Devices," to ensure "Download over metered connections" is "Off" under "Printers & scanners" and "Connected devices."

25

CHANGE PRINTER DEFAULT

If you've got two or more printers, go to "Settings → Devices → Printers & scanners," and flick the "Let Windows manage my default printer" switch to "On" if you want the printer to always default to the last one you used.

26

PROJECT YOUR PC

Project your display from one wireless PC or tablet to another—both need to support Miracast. Go to "Settings → System → Projecting on this PC" to verify this, then select "Available everywhere on secure networks." Now press Win-P on the device you want to extend, and click "Project to a second screen." Select '"Connect to a wireless display," select your target PC, and wait for the connection to be made, at which point your display can be duplicated or extended.

27

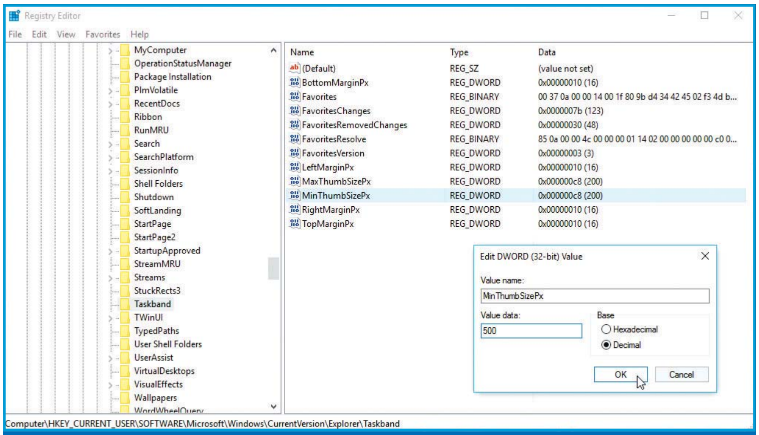
CAST VIDEO FROM EDGE

If you have a device capable of receiving Miracast or DLNA streams, you can cast media content such as YouTube video direct from Edge—navigate to the page containing your media, then click "..." and choose "Cast to Device." Wait for it to appear, then select it to switch output to that device.

28

TAME WINDOWS UPDATE

Make sure Windows Update doesn't suddenly reboot your PC without your permission. Go to "Settings → Update & security," and click "Change active hours" under "Windows Update" to set the time of day you're active on your PC. Updates will be scheduled to reboot outside this period only if you're not using your computer.


Registry Editor
File
Edit
View
Favorites
Help
MyComputer
OperationStatusManager
Package Installation
PlmVolatile
RecentDocs
Ribbon
RunMRU
Search
SearchPlatform
SessionInfo
Shell Folders
Shutdown
SoftLanding
StartPage
StartPage2
StartupApproved
StreamMRU
Streams
StuckRects3
Taskband
TWinUI
TypedPaths
User Shell Folders
UserAssist
VirtualDesktops
VisualEffects
Wallpapers
WordWheelQuery
OK
Cancel

Name	Type	Data
(Default)	REG_SZ	(value not set)
BottomMarginPx	REG_DWORD	0x00000010 (16)
Favorites	REG_BINARY	00 37 0a 00 00 14 00 1f 80 9b d4 34 42 45 02 f3 4d b...
FavoritesChanges	REG_DWORD	0x0000007b (123)
FavoritesRemovedChanges	REG_DWORD	0x00000030 (48)
FavoritesResolve	REG_BINARY	85 0a 00 00 4c 00 00 00 01 14 02 00 00 00 00 00 c0 0...
FavoritesVersion	REG_DWORD	0x00000003 (3)
LeftMarginPx	REG_DWORD	0x00000010 (16)
MaxThumbSizePx	REG_DWORD	0x000000c8 (200)
MinThumbSizePx	REG_DWORD	0x000000c8 (200)
RightMarginPx	REG_DWORD	0x00000010 (16)
TopMarginPx	REG_DWORD	0x00000010 (16)

Edit DWORD (32-bit) Value

Value name: MinThumbSizePx

Value data: 500

Base: ○ Hexadecimal ● Decimal

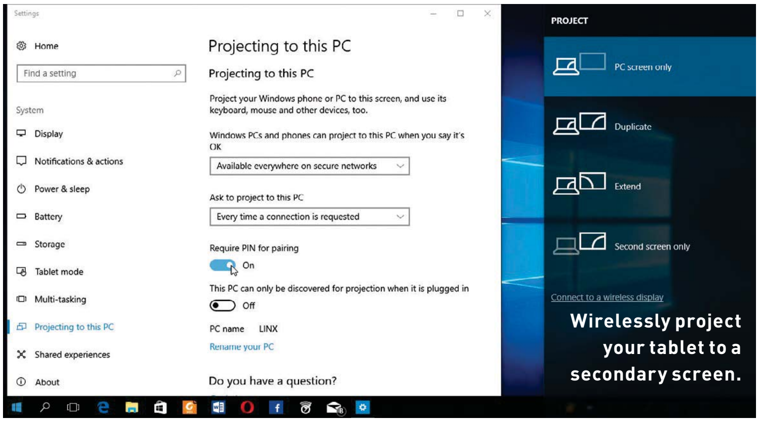
Computer\HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\Taskband

Quick-Fire Registry Tweaks

Many of Windows' hidden secrets are buried inside the Registry (access Registry Editor by pressing Win-R, typing "regedit," and hitting Enter). Here are some quick-fire tweaks you can't perform outside of the Registry.

Head over to HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer, then select the subkey indicated. Once done, locate the value shown (create a new DWORD 32-bit value if it's not already present), then change its data, selecting "Decimal" as the Base, unless stated. You need to open Task Manager, select "Windows Explorer" under "Processes" (click "More details" if necessary), and click the "Restart" button to apply the tweak(s).

SUBKEY	VALUE NAME	VALUE DATA	OBJECTIVE
Advanced	ShowSecondsInSystemClock	1	Show seconds in the Taskbar clock
Advanced	UseOLEDTaskbarTransparency	1	Increase transparency of the Taskbar
Advanced	ExtendedUIHoverTime	1	Speed up Aero Peek thumbnail preview
Advanced	LastActiveClick	1	Click Taskbar icon to cycle through open windows
Taskband	MinThumbSizePX	500	Increase size of Aero Peek thumbnail preview
RunMRU	Various	Various	A list of previously entered commands in the "Run" dialog—delete unwanted ones


Settings
Home
Find a setting
System
Display
Notifications & actions
Power & sleep
Battery
Storage
Tablet mode
Multi-tasking
Projecting to this PC
Shared experiences
About
PROJECT
PC screen only
Duplicate
Extend
Second screen only
Connect to a wireless display

Projecting to this PC

Projecting to this PC

Project your Windows phone or PC to this screen, and use its keyboard, mouse and other devices, too.

Windows PCs and phones can project to this PC when you say it's OK: Available everywhere on secure networks

Ask to project to this PC: Every time a connection is requested

Require PIN for pairing: On

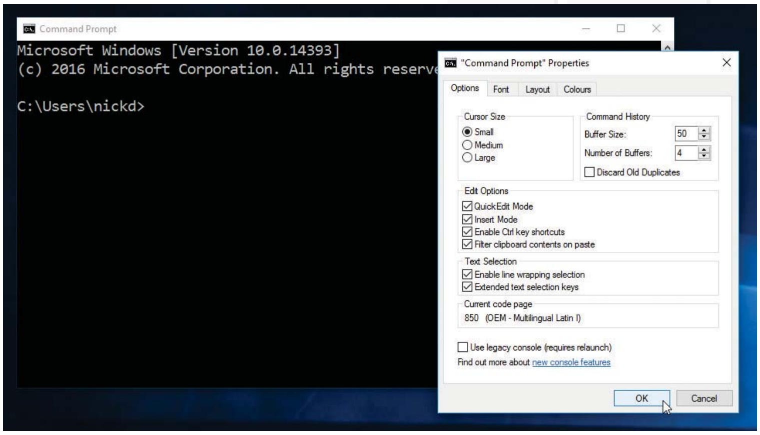
This PC can only be discovered for projection when it is plugged in: Off

PC name LINX

Rename your PC

Do you have a question?

Wirelessly project your tablet to a secondary screen.



```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserve

C:\Users\nickd>
```

Cursor Size
● Small
○ Medium
○ Large

Command History
Buffer Size: 50
Number of Buffers: 4
☐ Discard Old Duplicates

Edit Options
☑ QuickEdit Mode
☑ Insert Mode
☑ Enable Ctrl key shortcuts
☑ Filter clipboard contents on paste

Text Selection
☑ Enable line wrapping selection
☑ Extended text selection keys

Current code page
850 (OEM - Multilingual Latin I)

☐ Use legacy console (requires relaunch)
Find out more about new console features

Tweak the Command Prompt window to your liking.

29

MORE UPDATE OPTIONS

The Creator's Update introduces two new update options: click "Restart options" to pick an exact time of day for Windows Update to complete updates. Also, flick the "Show more notifications" switch to "On," and you'll be able to snooze updates for up to three days at a time.

30

ACTIVATION TROUBLESHOOTER

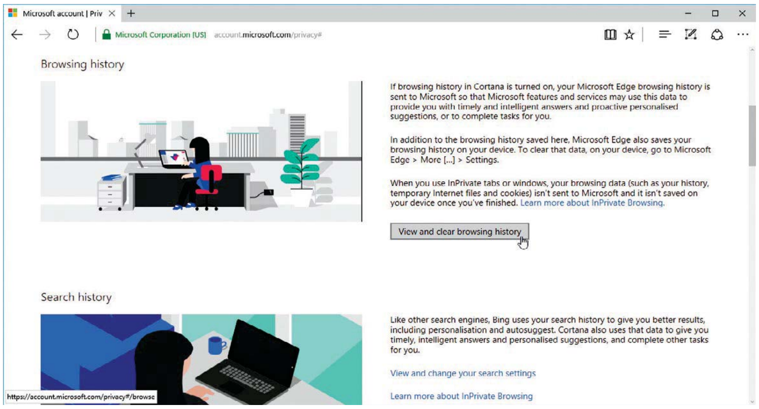
Here's some good news—if you took advantage of the free Windows 10 upgrade, then signed in with your Microsoft Account, your Windows license is linked to the account (do this manually via "Settings → Update & security → Activation → Add an account"). You can now perform major hardware surgery—including swapping out the motherboard—without losing your copy of Windows. If you run into problems with reactivation, click "Troubleshoot" on the "Activation" page, and select "I changed hardware on this device recently" to resolve them.

31

CUSTOMIZE COMMAND PROMPT

Windows 10 revamps the Command Prompt to provide lots of extra functionality, such as support for clipboard keyboard shortcuts and text wrapping. Configure these by right-clicking the Command Prompt menu bar and choosing "Properties." While you're here, customize the size, color scheme, and fonts, too.

Check what information is being shared with Microsoft.


Microsoft account | Priv
Microsoft Corporation [US]
account.microsoft.com/privacy#
View and clear browsing history
https://account.microsoft.com/privacy#/browse

Browsing history

If browsing history in Cortana is turned on, your Microsoft Edge browsing history is sent to Microsoft so that Microsoft features and services may use this data to provide you with timely and intelligent answers and proactive personalised suggestions, or to complete tasks for you.

In addition to the browsing history saved here, Microsoft Edge also saves your browsing history on your device. To clear that data, on your device, go to Microsoft Edge > More [...] > Settings.

When you use InPrivate tabs or windows, your browsing data (such as your history, temporary Internet files and cookies) isn't sent to Microsoft and it isn't saved on your device once you've finished. Learn more about InPrivate Browsing.

Search history

Like other search engines, Bing uses your search history to give you better results, including personalisation and autosuggest. Cortana also uses that data to give you timely, intelligent answers and personalised suggestions, and complete other tasks for you.

View and change your search settings

Learn more about InPrivate Browsing

32

ACCESS DEVELOPER TOOLS

Go to "Settings → Update & Security → For Developers," and select "Developer Mode" under "Use developer features." Tweaks include "developer-friendly" options for Windows Explorer, such as showing full directory paths in the title bar.

33

RUN BASH COMMANDS

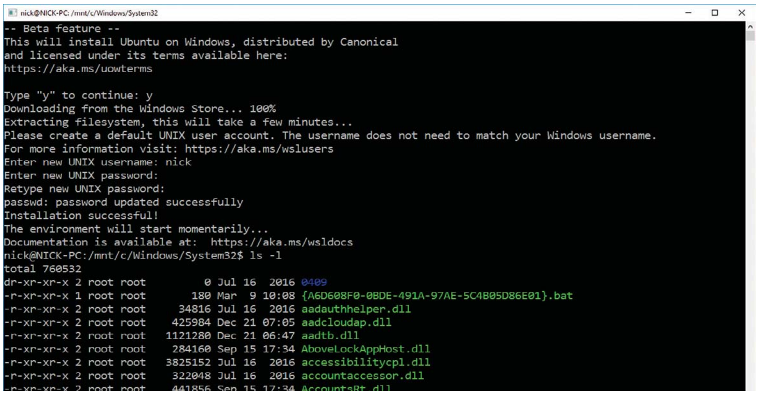
You can run Linux commands in Windows when Developer Mode is enabled via the Bash UNIX Shell—right-click "Start," and choose "Programs and Features," then click "Turn Windows features on or off." Select "Windows Subsystem for Linux (Beta)." Click "OK," and reboot when prompted.

34

BASH LIMITATIONS

Once enabled, press Win-R, type "bash," and hit Enter to install Ubuntu on Windows. You can then run command-line Linux apps and Bash commands via the Bash on Ubuntu on Windows app, or by invoking Bash from the Command Prompt, like so:

```
$ bash ls -l
```



```
-- Beta feature --
This will install Ubuntu on Windows, distributed by Canonical
and licensed under its terms available here:
https://aka.ms/uowterms

Type "y" to continue: y
Downloading from the Windows Store... 100%
Extracting filesystem, this will take a few minutes...
Please create a default UNIX user account. The username does not need to match your Windows username.
For more information visit: https://aka.ms/wslusers
Enter new UNIX username: nick
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Installation successful!
The environment will start momentarily...
Documentation is available at:  https://aka.ms/wsldocs
nick@NICK-PC:/mnt/c/Windows/System32$ ls -l
total 760532
dr-xr-xr-x 2 root root        0 Jul 16  2016 0409
-r-xr-xr-x 1 root root      180 Mar  9 10:08 {A6D608F0-0BDE-491A-97AE-5C4B05D86E01}.bat
-r-xr-xr-x 2 root root    34816 Jul 16  2016 aadauthhelper.dll
-r-xr-xr-x 2 root root   425984 Dec 21 07:05 aadcloudap.dll
-r-xr-xr-x 2 root root  1121280 Dec 21 06:47 aadtb.dll
-r-xr-xr-x 2 root root   284160 Sep 15 17:34 AboveLockAppHost.dll
-r-xr-xr-x 2 root root  3825152 Jul 16  2016 accessibilitycpl.dll
-r-xr-xr-x 2 root root   322048 Jul 16  2016 accountaccessor.dll
-r-xr-xr-x 2 root root   441856 Sep 15 17:34 AccountsRt.dll
```

Run Linux commands in Windows—really!

35

IMPROVE BATTERY LIFE

Make your laptop or tablet run further between charges by going to "Settings → System → Battery," and switching on Battery Saver. Push the slider up to 70 or even 80 percent, then tap "Battery usage by app" to see which apps require most power. Consider replacing them with more power-efficient alternatives (such as the Opera web browser instead of Edge, for example).

36

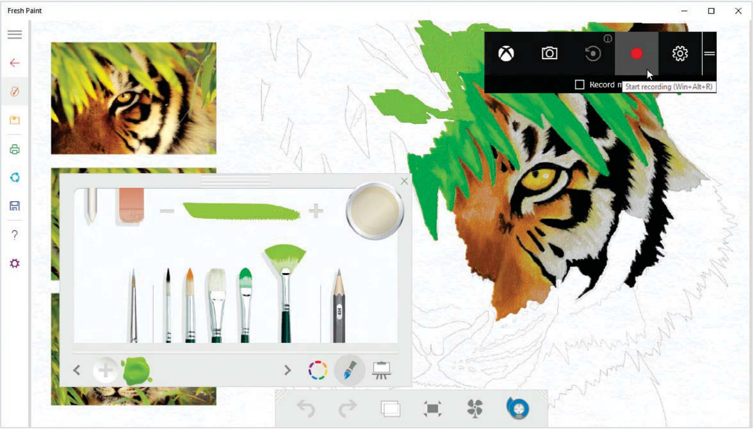
LOCK DOWN WI-FI

Make sure you're not exposed to insecure wireless networks: go to "Settings → Network & Internet → Wi-Fi." Make sure "Connect to suggested open hotspots" is disabled if you don't connect through a VPN.

37

RUN A PRIVACY SWEEP

Go to http://account.microsoft.com/privacy, where you'll find a web dashboard providing convenient shortcuts to reviewing and clearing


Fresh Paint
Record
Start recording (Win+Alt+R)

Record footage from any app with Game DVR.

personal data stored in the cloud, including Cortana Notebook. You can also perform a local audit via "Settings → Privacy," but if this is all too confusing, run the portable O&O ShutUp 10 tool (www.oo-software.com/en/shutup10) for a one-click solution.

38 OPTIMIZE ONEDRIVE

Right-click the OneDrive Taskbar Notification area icon, and choose "Settings." Click "Choose folders" under "Account" to sync selective content to your PC, and set bandwidth limits under the "Network" tab if you think OneDrive is adversely affecting your Internet connection. Go to the "Office" tab and deselect both boxes if you find Office defaulting to your online file copies instead of those stored locally.

39 RECORD VIDEO FROM ANY APP

The Game DVR function exists to allow you to record your gaming exploits, but you can use it on any app you install from the Windows Store. Simply open the app, press Win-G, and check "Yes, this is a game" when prompted to open it.

40 DITCH OFFICE INSTALL PROMPT

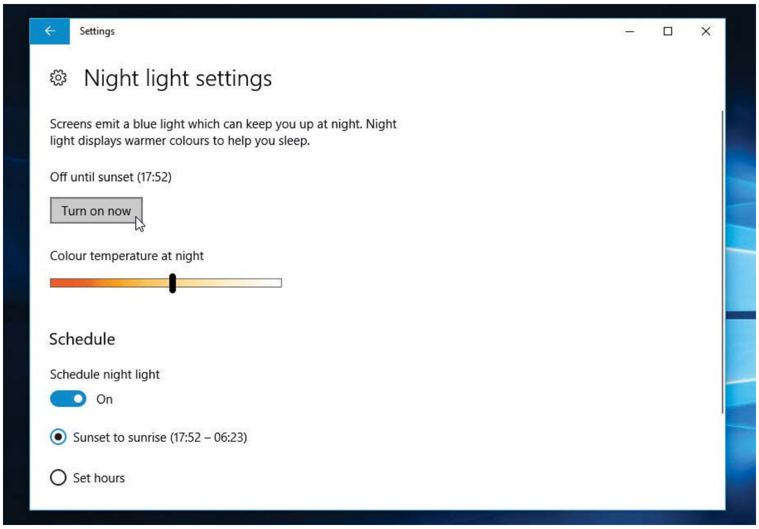
Fed up with being constantly reminded to install Office? Open the "Start" menu, locate the "Get Office" shortcut in the "All apps" menu, then right-click it, and choose "Uninstall" to remove both the prompt and the underlying application.

41 SWITCH REGISTRY HIVES QUICKLY

Many Registry entries are mirrored between HKEY_LOCAL_MACHINE and HKEY_CURRENT_USER. Gone to the wrong hive accidentally? Simply right-click the key, and choose "Go to HKEY..." to jump to its corresponding entry in the other hive.

42 APPLY POLICY CHANGES THROUGH REGISTRY EDITOR

Windows 10 Professional comes with the Group Policy Editor (gpedit.msc), which is often used to configure security settings. If you're running Windows 10 Home, you can apply many of these tweaks with the right Registry settings, which you'll find neatly summarized as an Excel spreadsheet—go to https://www.microsoft.com/en-us/download/details.aspx?id=25250 to download it.



Night light settings

Screens emit a blue light which can keep you up at night. Night light displays warmer colours to help you sleep.

Off until sunset (17:52)

Turn on now

Colour temperature at night

Schedule

Schedule night light

On

● Sunset to sunrise (17:52 – 06:23)

○ Set hours

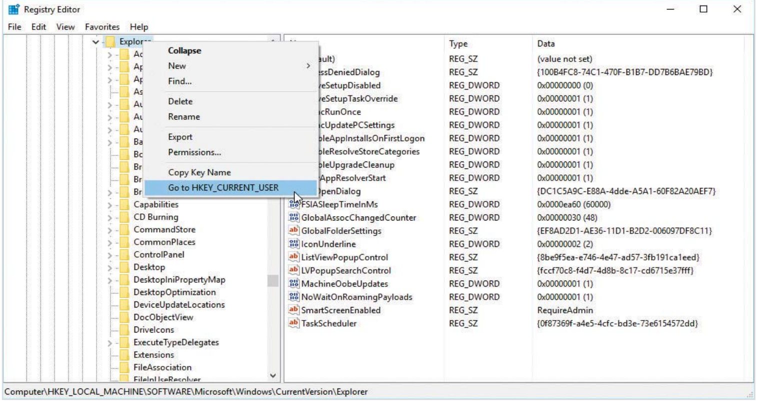
The Creator's Update is easier on the eye.

43 VERIFY PROGRAM SIGNATURES

How can you be sure that a program you download is the real deal? Right-click the downloaded file, and choose the "Properties → Digital Signatures" tab to view the certificate that should help identify its origin. If the website provides an MD5 or SHA1 hash, you can use HashMyFiles (www.nirsoft.net/utils/hash_my_files.html) to compare the file's hash with that on the site.

44 INDEPENDENT DISPLAY SCALING

If you have two monitors with different resolutions—one that's 4K, for example, while the other is HD—then Windows 10 now enables you to scale each display completely independently of the other. To do this, go to "Settings → System → Display," select your display by clicking it, then use the slider to increase the size of text, apps, and other on-screen elements. Click "Advanced display settings" to change its resolution.


Registry Editor
File
Edit
View
Favorites
Help
Explor
Ac
Ap
Ap
As
Au
Au
Au
Ba
Bc
Br
Br
Br
Capabilities
CD Burning
CommandStore
CommonPlaces
ControlPanel
Desktop
DesktopIniPropertyMap
DesktopOptimization
DeviceUpdateLocations
DocObjectView
DriveIcons
ExecuteTypeDelegates
Extensions
FileAssociation
FileInUseResolver
Collapse
New
Find...
Delete
Rename
Export
Permissions...
Copy Key Name
Go to HKEY_CURRENT_USER

	Type	Data
ault)	REG_SZ	(value not set)
ssDeniedDialog	REG_SZ	{100B4FC8-74C1-470F-B1B7-DD7B6BAE79BD}
eSetupDisabled	REG_DWORD	0x00000000 (0)
eSetupTaskOverride	REG_DWORD	0x00000001 (1)
cRunOnce	REG_DWORD	0x00000001 (1)
cUpdatePCSettings	REG_DWORD	0x00000001 (1)
leAppInstallsOnFirstLogon	REG_DWORD	0x00000001 (1)
leResolveStoreCategories	REG_DWORD	0x00000001 (1)
leUpgradeCleanup	REG_DWORD	0x00000001 (1)
AppResolverStart	REG_DWORD	0x00000001 (1)
penDialog	REG_SZ	{DC1C5A9C-E88A-4dde-A5A1-60F82A20AEF7}
FSIASleepTimeInMs	REG_DWORD	0x0000ea60 (60000)
GlobalAssocChangedCounter	REG_DWORD	0x00000030 (48)
GlobalFolderSettings	REG_SZ	{EF8AD2D1-AE36-11D1-B2D2-006097DF8C11}
IconUnderline	REG_DWORD	0x00000002 (2)
ListViewPopupControl	REG_SZ	{8be9f5ea-e746-4e47-ad57-3fb191ca1eed}
LVPopupSearchControl	REG_SZ	{fccf70c8-f4d7-4d8b-8c17-cd6715e37fff}
MachineOobeUpdates	REG_DWORD	0x00000001 (1)
NoWaitOnRoamingPayloads	REG_DWORD	0x00000001 (1)
SmartScreenEnabled	REG_SZ	RequireAdmin
TaskScheduler	REG_SZ	{0f87369f-a4e5-4cfc-bd3e-73e6154572dd}

Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer

Switch Registry hives with two quick clicks.

45

REDUCE EYE STRAIN

The Creator's Update introduces a new feature that changes the color temperature of your screen at night-time, which should help you sleep better and avoid eye strain. Switch it on via "Settings → System → Display." Tap "Night light settings" to set it up (flick the schedule on, and use the recommended sunset-sunrise setting, which changes based on your location and the time of year).

46

MASTER TOUCH GESTURES

If you have a touchscreen or touchpad, you should make use of gestures. Swipe with two fingers to scroll, for example, or swipe with three fingers horizontally to move between open windows, or vertically to shift between Task View and hiding everything but the desktop. Open the Mouse control panel, and check for a tab called "Device Settings," where you may find options for customizing your own gestures.

47

SPEED UP REMOVABLE DRIVES

If you are willing to give up the ability to safely remove drives without ejecting them first, you can enable writing caching on the drive for a speed boost. Open Device Manager, then double-click your target drive under "Disk Drives." Switch to the "Policies" tab to make your choice.

48

SWITCH PLAYBACK DEVICE

Most problems regarding lost sound can usually be traced to Windows switching the playback device. Quickly review (and change) the current playback device by clicking the Taskbar Notification area's audio device icon. Click "^" to reveal all available devices, and select the correct one to bring your sound back.

49

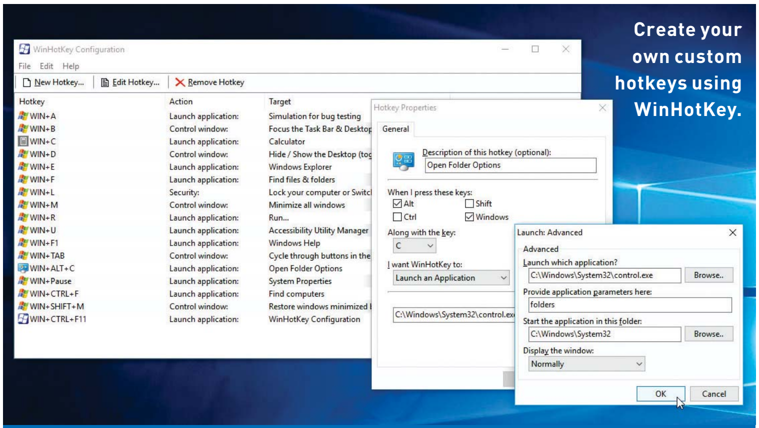
BECOME A DIGITAL MEDIA SNOB

Windows 10 now comes with native support for MKV, HVEC, and the lossless FLAC audio format. Open Windows Media Player, and click "Rip settings → Format → FLAC (Lossless)" to make it the default choice for future CD rips, ensuring they're stored at maximum quality.

50

GET AN ENERGY REPORT

Open the Command Prompt, type "powercfg –energy," and then hit Enter. Now double-click the energy-report.html file that's been generated (in your Windows\System32 folder) to get an overview of the energy-saving capabilities of your computer and its peripherals. The report can help you to root out potential issues with sleep and hibernation. It's also worth checking suspect devices through Device Manager, where you should look for a "Power Management" tab, which enables you to prevent certain devices from bringing your PC prematurely out of standby. ⏻



Hotkey	Action	Target
WIN+A	Launch application:	Simulation for bug testing
WIN+B	Control window:	Focus the Task Bar & Desktop
WIN+C	Launch application:	Calculator
WIN+D	Control window:	Hide / Show the Desktop (tog
WIN+E	Launch application:	Windows Explorer
WIN+F	Launch application:	Find files & folders
WIN+L	Security:	Lock your computer or Switc
WIN+M	Control window:	Minimize all windows
WIN+R	Launch application:	Run...
WIN+U	Launch application:	Accessibility Utility Manager
WIN+F1	Launch application:	Windows Help
WIN+TAB	Control window:	Cycle through buttons in the
WIN+ALT+C	Launch application:	Open Folder Options
WIN+Pause	Launch application:	System Properties
WIN+CTRL+F	Launch application:	Find computers
WIN+SHIFT+M	Control window:	Restore windows minimized
WIN+CTRL+F11	Launch application:	WinHotKey Configuration

Description of this hotkey (optional): Open Folder Options

When I press these keys:
☑ Alt ☐ Shift
☐ Ctrl ☑ Windows

Along with the key: C

I want WinHotKey to: Launch an Application

C:\Windows\System32\control.ex

Launch which application? C:\Windows\System32\control.exe

Provide application parameters here: folders

Start the application in this folder: C:\Windows\System32

Display the window: Normally

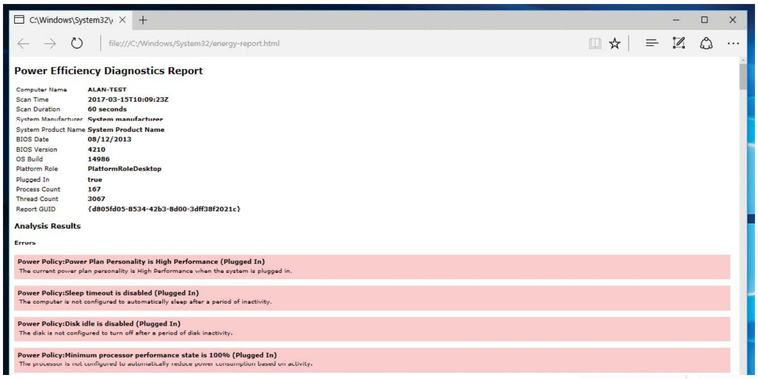
Create your own custom hotkeys using WinHotKey.

Oft-Forgotten Keyboard Shortcuts

Touchscreens, trackpads, mice—they're all great, but they're no substitute for the keyboard. Find the right keyboard shortcut and you can skip straight to the action. We won't insult your intelligence by revisiting well-known shortcuts (head over to https://support.microsoft.com/help/12445/ for a comprehensive list), but here are some shortcuts you may have forgotten (or never knew existed).

SHORTCUT	WHAT IT DOES
Shift-F10	Performs a right-click at the current cursor point
Win-Pause/Break	Accesses System Properties
Win-D	Minimizes all windows (press again to restore)
Win-X	Opens the "Quick Link" menu
Win-U	Opens "System → Ease of Access"
Win-B	Focuses on Taskbar Notification Area—use cursor keys to navigate, Enter to select
Win-A	Opens Action Center (use Win-V to cycle through notifications)
Win-H	Opens Share charm
Win-I	Opens Settings
Win-+/-	Zooms in and out using Magnifier (use Win-Esc to close it)

If you'd like to create your own custom keyboard shortcuts using a combination of the Win, Ctrl, and Alt keys, download WinHotKey from www.directedge.us/content/winhotkey—it works fine in Windows 10.



Power Efficiency Diagnostics Report

```
Computer Name          ALAN-TEST
Scan Time              2017-03-15T10:09:23Z
Scan Duration          60 seconds
System Manufacturer    System manufacturer
System Product Name    System Product Name
BIOS Date              08/12/2013
BIOS Version           4210
OS Build               14986
Platform Role          PlatformRoleDesktop
Plugged In             true
Process Count          167
Thread Count           3067
Report GUID            {d805fd05-8534-42b3-8d00-3dff38f2021c}
```

Analysis Results

Errors

```
Power Policy:Power Plan Personality is High Performance (Plugged In)
The current power plan personality is High Performance when the system is plugged in.

Power Policy:Sleep timeout is disabled (Plugged In)
The computer is not configured to automatically sleep after a period of inactivity.

Power Policy:Disk idle is disabled (Plugged In)
The disk is not configured to turn off after a period of disk inactivity.

Power Policy:Minimum processor performance state is 100% (Plugged In)
The processor is not configured to automatically reduce power consumption based on activity.
```

Keep tabs on your PC's energy-saving aptitude.

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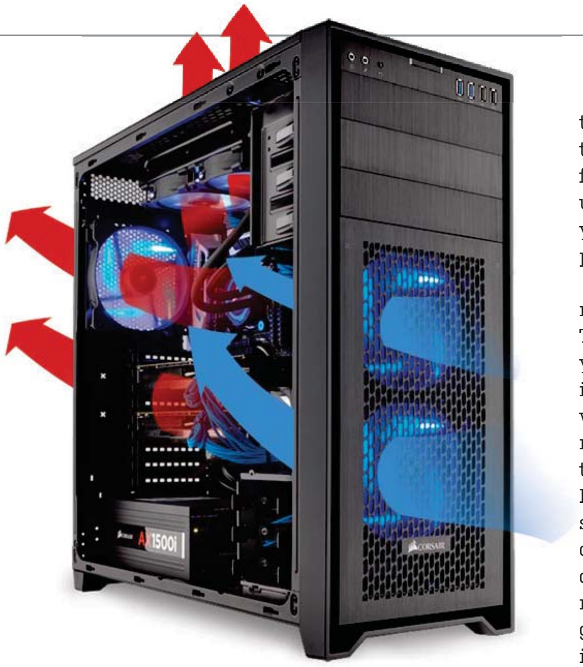
THE FAN ZONE

Fans are simple enough, right? Not quite. There are a few things you need to learn before you can pick with confidence. *By Chris Lloyd*

PASS ELECTRICITY through a conductor, and it gets hot. All the little electrons bump into things and transfer energy. This bit of basic physics is useful for an electric fire, but a real annoyance for your silicon, which needs to be kept cool. Back in the day, the only fan you might have had on a computer was in the power supply, blowing hot air out. The Intel 486 was the first processor to need a fan of its own, on the faster versions anyway. The original Pentium could just about manage on passive cooling in its slower incarnations, but was likely to pop under load if you weren't careful (no universal fail-safe thermal cut-offs back then—if you overheated it, you may well have killed it). Since then, every chip has needed dedicated cooling. Graphics cards soon started to get too hot to run unaided, too. The fans got bigger, and spread. Now, some motherboard chipsets, drives, and even memory modules sport fans. And case fans have proliferated into banks of spinning LED lights all over the case.

If you run an unmodified rig, the fans it came with will work well enough, albeit too noisily for comfort. If nothing else, a good fan is quieter. If you start upgrading and overclocking, adequate cooling is imperative—time to add new fans. At least they're simple. Actually, like every aspect of PCs, fans have their own specifications and variations in design and function, so there are a few things it would be useful to know first. Although getting the "right" number and position is still something of a dark art.

NZXT
RAIJINTEK CORPORATION



Corsair's diagram of its 750D case, showing the recommended fans. High pressure blowing in at the front, and high airflow ones blowing out at the back and top. The PSU is tucked away out of the airflow.

THE SPECIFICATIONS

The primary stats to look for are how much air the fan can shift, and how much noise it makes. Airflow is measured in CFM—cubic feet per minute. The fan's "push" or static pressure is usually quoted using the delightfully archaic measure of millimeters of water. Higher is better. Noise level is measured in dB, a similarly obscure value, which takes careful reading (see box below). Among the specs you'll also find its maximum rotational speed, bearing type, control method, MTBF, blade design, and anything else the marketing men think you might be interested in, or impressed by, including fancy rubber mounts, color schemes, and LED lights.

The most basic stat is size. Case and processor fans have been getting bigger—80 and 92mm soon grew to 120 and 140mm, then 200 and 230mm. A bigger fan means lower speed for the same airflow, so if you have room, go big. Unless you fancy cutting holes, your case defines how many and what size you can fit. A decent case offers a good choice of number and position.

Next is the most basic function of any fan: moving air. CFM is an intuitive measurement. A 120mm fan can shift 40–100 CFM, depending on its blade design and rotational speed. This is a wide range, which isn't terribly helpful information on its own. The big 200 and 230mm case fans can move more air—100–150 CFM—and, more importantly, do it at lower speeds.

How much air do you need to shift? Opinion is divided; there's a huge number of variables at play here, but, very roughly, around 50 CFM or so should keep everything frosty enough on a fairly standard rig. If you've been tinkering and upgrading, you might like to bump that up a bit. You won't need hundreds, though.

The internal layout has a huge impact on airflow: The tighter and more restrictive the interior space is, the harder the fans have to work, and the more likely it is that you'll get hotspots. The CFM figure is measured on a completely unobstructed fan, too—as soon as you add some back pressure, the performance drops off.

It's also worth remembering to match your input and output fans. Tweaking these values can give you a negative or positive pressure inside your case. The jury is out on which is best, or whether it makes much difference at all. The idea is that if you push more air into your PC, it's pressurized a little, which stops air finding its way through cracks and gaps, and bringing in dust. In theory, it keeps the inside nice and clean, assuming you've got effective air filters over the input fans. Detractors point out that it can lead to a build up of heat, and doesn't really work well anyway.

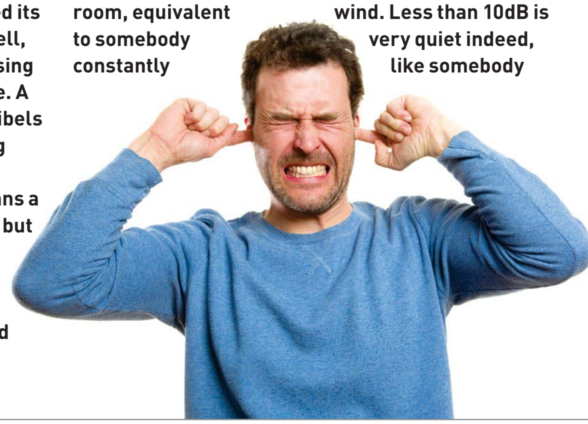
A fan's static pressure is how much force it can apply to the airflow. You don't need to know how or why this is measured in millimeters of water, just know that more is better. A typical 120mm case fan runs to 1.0–2.0mm. A high static pressure fan is good for forcing air into all the nooks and crannies of your machine, or through a radiator attached to a water cooler, say.

Airflow, air pressure, and rotational speed are all related, and there's a trade-off involved. Fans are often designated as "static pressure" or "airflow," designed to maximize

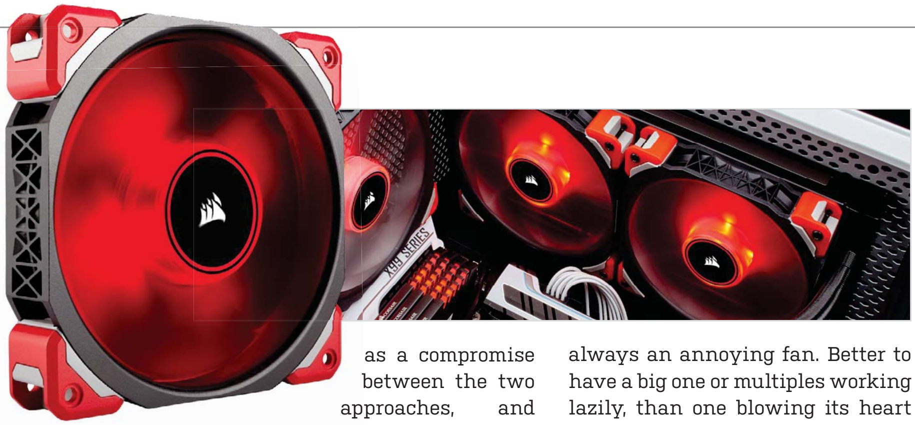
THE DECIBEL

The standard unit used to define how much noise something makes is the decibel, dB. This unit dates back to the days of the telegraph, and is named in honor of Alexander Graham Bell. As the name also suggests, it is equal to a tenth of a bel, a unit you won't see used anywhere these days. It was devised to quantify signal loss over the wires. Best known for its use in acoustics, it can also be applied to voltages in electronics, radar, radio field strengths, and more. Most importantly, it is not a linear scale. It's logarithmic—a ratio of two values: the one you want to measure and a reference value, which, in the case of acoustics, is silence. A logarithmic scale may have suited its original purposes well, but makes it a confusing unit for everyday use. A difference of six decibels is equal to a doubling of air pressure. You might think that means a sound twice as loud, but because of the way the brain processes sound, that doesn't follow. The perceived volume doubles at around 10dB difference.

Small differences in decibels equal a big difference in noise. A fan at full bore can make 30dB or more, an intrusive level in a quiet room, equivalent to somebody constantly whispering in your ear. What manufacturers consider "quiet" varies, but look for under 25dB. Properly quiet would be under 20dB, about the same as leaves gently rustling in the wind. Less than 10dB is very quiet indeed, like somebody breathing. The human ear is more sensitive to certain frequencies, which makes a straight dB rating an imperfect measure of the obtrusiveness of a sound. It may only be as loud as rustling leaves, but it's an annoying high-pitched whine, too. It's also worth remembering that adding dB values isn't linear either—two fans of the same decibel level are 3dB louder in total. That's another reason for going for two fans over a single more powerful, but louder, one.



static pressure or CFM respectively. This boils down to the design of the rotor blades. Static pressure fans have thick blades with narrow gaps, leaving the air little place to go but through the fan, but less air is shifted with each rotation. On the exhaust side, the airflow tends to spread out into a cone. These are usually recommended for front case input fans, or if you have to mount the fan in a confined space.



Corsair's ML120 fans produce a staggering 4.2mmH$_2$O at 37dBA. But thanks to a 400rpm running speed, set these to spin at a low rpm and they still pump out some serious pressure. Ideal for any radiator, AIO, or air tower.

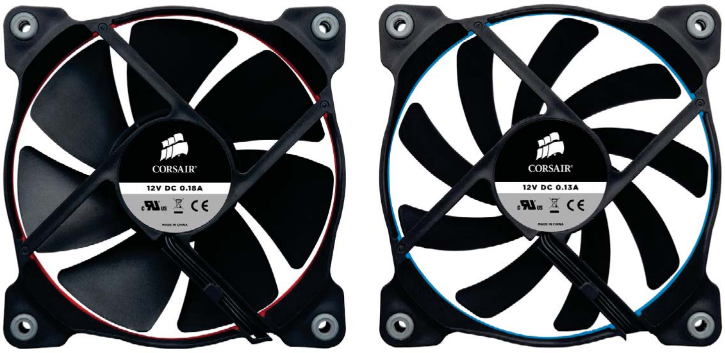
Blades designed for maximum airflow are much thinner—you can get your fingers between them on a 120mm. The exhaust flow is tighter and more directional—handy if you have a specific hotspot to cool. They are usually recommended as rear-mounted exhaust fans, good at shifting large volumes quickly against minimal back pressure. Hybrid designs mix blade shapes as a compromise between the two approaches, and often recommended as CPU fans.

The maximum quoted rpm is not quite as important as it sounds. Depending on the blade design, it defines the maximum airflow and pressure values. To keep things quiet and unstressed, you don't really want to run at full tilt anyway. The noise it makes at typical operating speeds is important, though; a noisy fan is always an annoying fan. Better to have a big one or multiples working lazily, than one blowing its heart out to reach the cooling you need. On variable speed fans, you have a maximum and minimum dB level. The lower figure is as useful to know as the maximum—it gives you a good idea of how much quieter it is running below its maximum.

BEARING DOWN

Now for bearings. Old-school sleeve bearings have been around in one

Noctua fans are nicely put together and beautifully designed.

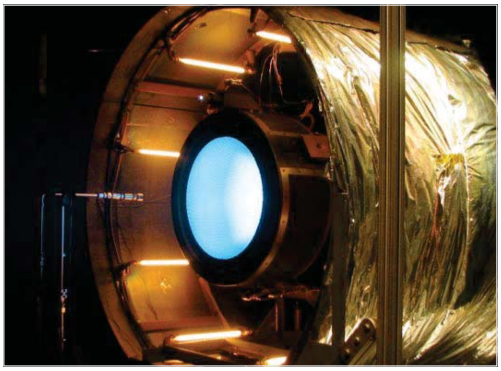


Same fan, different blades. The thick blades are optimized for high pressure, while the thinner blades are aimed at maximizing airflow.

FUTURE COOLING

Is there a better way to cool things down than the positively ancient technology of a fan? There have been plenty of ideas. How about using ionic wind? It has no moving parts at all. It works by creating a flow of air using a thin ionizing anode and a large cathode. MIT and NASA have played with the technology as a possible low-emission replacement for jet engines, but so far nothing much has come of it, due to low thrust densities. There have been some lovely home-brew experiments on PCs that appear to work. The main, and absolutely huge, drawback is the massive voltages required—not something you want inside a PC.

Another cooler with no moving parts uses the Peltier or thermoelectric effect. This consists of a sandwich of different materials—typically, carefully arranged p and n-type semiconductors—which has a current passed across it. Heat is transferred from one side to the other as the material tries to find equilibrium among the electrons. It can heat or cool, depending on which way round you place it. It all works well enough, but it's not the most efficient of systems, the cooling effect isn't very strong (about 20 degrees difference), and it requires quite a bit of power. The heat isn't taken very far away either—just across a relatively thin material. On a processor, you would still need something on the other side of your Peltier cooler to carry the heat further away. There is potential, but it has yet to prove itself in anything other than specialist applications. They may be as old as the hills, but fans are cheap and do the job. A good combination.



Unfortunately, the ion thruster from NASA proved impractical outside the world of space probes.

form or another since the pharaohs. These use a lubricated tubular sleeve around the drive shaft. They don't like high temperatures, or being oriented anything but vertically. However, they are cheap and can be quiet, particularly when new. After a while, the lubricant dries out and the fan gets noisy. They also have an unpleasant habit of failing rather suddenly; if it starts to squeal, it could be on borrowed time. The lifespan drops at higher temperatures, too, because heat affects the viscosity of the lubricant, typically halving between 25 and 50 C.

The next best thing is a ball bearing. The Romans used simple versions, and Leonardo da Vinci sketched a ball bearing as part of his helicopter design. However, it wasn't until 1794 that we had a modern design. Here, the drive shaft is surrounded by ring of small ball bearings, held in contact by an outer tube. The ball bearings rotate individually, and around the shaft. This lowers friction. It's a sealed unit, so the lubrication dries out more slowly than sleeve bearings. Ball bearings last a good deal longer and tolerate higher temperatures better than sleeve bearings, too, as well as being tolerant to orientation.

Fluid bearings immerse the shaft in a lubricating liquid to lower friction. They can have an excellent lifespan and be very quiet. The original FDB, fluid dynamic bearings, came from the world of hard drives, and feature a rifled or grooved inner surface to the bearing to keep the lubricant moving. The drive shaft spins in a thin layer of lubricant—essentially, a modified sleeve bearing. However, this design is patented, so similar but subtly different designs have appeared, going under various names. Hydro dynamic—or simply hydraulic—bearings are similar in design and operation. Rifled bearings range from simple modified sleeve bearings that are of questionable value to more sophisticated designs

The Be Quiet! 120mm Silent Wings 3 puts out just 16.4dB, yet shifts over 50CFM.

F12
SILENT
ARCTIC

Artic's F12 Silent is a fixed-speed DC fan, but at 20.5dB, it delivers over 38CFM using a fluid bearing.

Cooler Master's new PWM MasterFan Pro range has a 490,000-hour life.

MAGNETIC LEVITATION

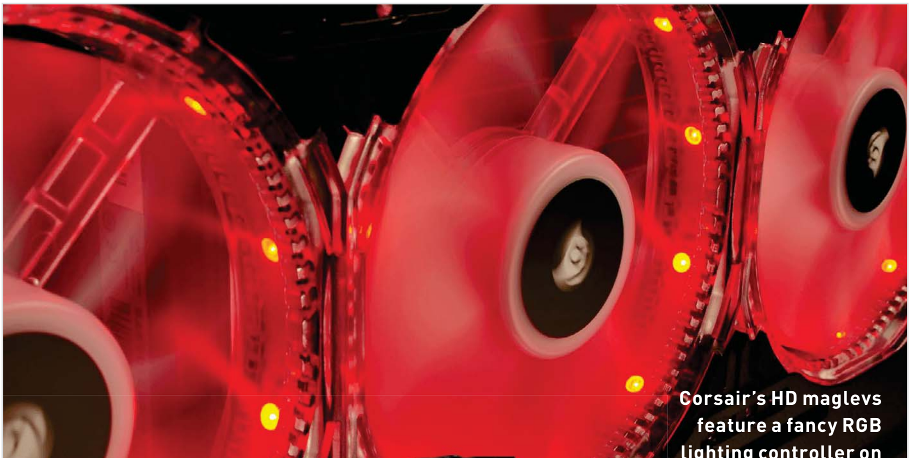
A weak point of a bearing is the point of contact between the surface of the drive shaft and the bearing—however clever the design, two surfaces moving at different speeds creates friction, noise, and vibrations. Enter the use of magnetic levitation, which effectively removes any contact. The shaft and fan assembly is held in magnetic suspension by a ring of electromagnets, and rotated by pulses of changing polarity around the ring. No contact means precious little noise and wear. It also enables the fan to rotate accurately around its center of gravity, eliminating vibration. No contact also greatly improves reliability.

The idea for maglev bearings has been around since the early 1940s, and was proposed for the high-speed centrifuges used to enrich uranium for the Manhattan Project. However, it took until the 1970s before commercial applications emerged; these include maglev trains, and pumps for use in space, artificial hearts, and other extreme environments. Now the technology has filtered down to the relatively humble fan in a PC, thanks largely to cheap solid-state controllers. It sounds just great, but we've yet to be properly impressed. So far, just Corsair and Sunon have tried the technology—Corsair to the greater acclaim. Its ML range can spin to 2,400rpm, although at 37dB, you might not want them to for long. It's still early days for this technology in PC fans, and we hope to see more and better to follow.

Same principles as a maglev bearing, and with the same aim: reduce friction and go faster.

that approach the effectiveness of the original.

That used to be pretty much it, but magnetic levitation bearings have started to appear (see box below-left). These radically reduce friction again. Once the province of major engineering projects, such as high-speed centrifuges, the tech has dropped into the mainstream. Corsair launched a range of magnetic levitation fans last year. Magnetic levitation bearings have yet to make much impact, though — the technical advantages are there to be had, but not fully realized.



Corsair's HD maglevs feature a fancy RGB lighting controller on top of the bearings.

thermaltake

Thermaltake's colorful Riing range features hydraulic bearings and 256 or 16.8 million color RGB lights, controllable from software.

CONTROL

There are two main forms of control: DC and PWM. A basic DC fan takes your 12V supply, runs it through the fan, and off you go. It works fine, but you have a fixed speed—it's either on or off, and that's about it. DC fans have three-pin connectors. You can reduce the voltage with a simple potentiometer—a variable resistor between the PSU and fan, once very popular with modders. It adds direct control over fan speed, but you are on your own when you set the level of cooling, it wastes power, and generates its own heat.

Enter pulse width modulation, or PWM. This adds another pin to the connector to carry a control signal, which enables precise software control of fan speed. It works by very quickly switching power on and off at modulated intervals. Because the fan is still getting the full 12V, it can be controlled down to very low speeds; a DC fan would start to stall as voltages drop toward 5V. Every decent motherboard has at least one PWM header, and you should use it.

Some fans have integrated speed controls, enabling you to select a speed profile or a set of fixed speeds. PWM control makes this feature largely redundant. PWM enables your system to react to sudden changes in load seamlessly.

Every fan will die at some point. Fans have an MTBF rating: mean time before failure, the average lifespan. If it's going into a very important system on a remote island, longevity is worth careful consideration. Otherwise, some simple math shows us that, given modern fans' high reliability, it's not as important as it once was. A cheap sleeve bearing fan might only last 30,000 hours, but decent fans run to 100,000 or 200,000, and more. Even a very modest 50,000-hour fan will last 5.7 years of continuous use. Will you still be running the same system in 2022?

What's left? Some system of vibration damping using silicone rubber mounts is desirable. Fancy sculpted airflow around the fan case can squeeze tiny benefits out of performance, and there are a few spurious claims made for oddly shaped and toothed blades, which may, or may not, hold water.

Lastly we have aesthetics. Fancy colored plastics and transparent parts can look funky, but best of all are LEDs. These are so cheap now that even budget fans often come festooned with tiny lights. Not funky enough? How about RGB lights, an array of customizable multi-colored lights that can be set to flash, strobe, fade between colors, and more? Pointless but great fun.

How much? A basic sleeve bearing DC 120mm fan with an LED or two is under five bucks, but you don't want that. A decent ball bearing Noctua is about $20, and a magnetic levitation Corsair with fancy lights is $25. Given what you are likely to spend on the rest of your hardware, especially your graphics card, this is small change. You may as well buy decent ones, and fit enough capacity so none has to strain itself. Running cool helps everything last longer.

It's easy to go overboard. One case fan at the front and one at the back might be enough for most uses, but adding more is tempting, and doubling up won't hurt, especially on a high-power gaming rig.

There is a law of diminishing returns at work, though. Once you've got decent airflow over all the components, adding extra fans does little more than make it look fancier. There is a limit to the airspeed you can achieve over any component from a 12V fan; adding too many or badly positioned ones can cause turbulence and heat traps, and set fans working against each other, especially if you add them to every case opening.

If in doubt, experiment. Software can monitor how hot your processor and graphics card are running. Try changing the position of your fans, and adjusting the speeds. There are few hard and fast rules, and lots of common sense, such as keeping the paths for incoming air and exhaust air clearly delineated, and not putting inputs at the top or near the PSU output.

Your rig can never run too cool or too quietly. It might cope with a couple of basic fans, but there is something wonderfully reassuring about having a good set of fans quietly whirring away. It's cool.

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Peerless storage
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Stay hidden from GCHQ
Keep safe online with next-gen Tor browsing
Discover CentOS
» Get to grips with the best server distro and our guide
Roundup
Explore BSD
» The best options for the 'other' open source kernel
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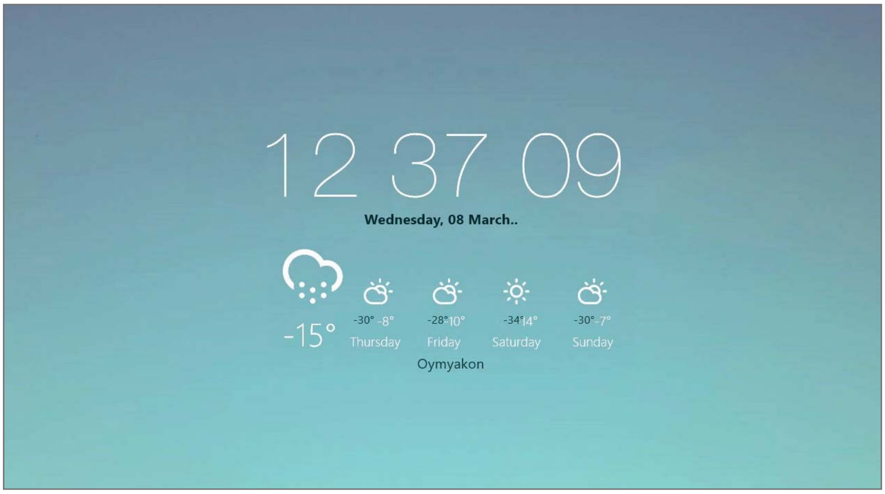
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

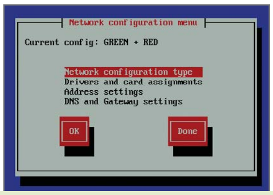
TIP OF THE MONTH


12 37 09
Wednesday, 08 March..
-15°
-30° -8°
Thursday
-28° 10°
Friday
-34° 14°
Saturday
-30° -7°
Sunday
Oymyakon

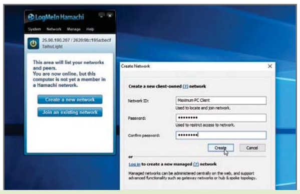
RAINMETER

I love a clean desktop: icon- and clutter-free, with a slick background, and only essential information. Rainmeter can help bolster that, with a variety of community-developed skins and widgets, showing everything from clocks to weather to system resource use, notepads, and RSS feeds. This particular theme is Simplony, by HipHopium on www.deviantart.com. Head to www.rainmeter.net to download the base app.

MAKE – USE – CREATE


Network configuration menu
Current config: GREEN + RED
Network configuration type
Drivers and card assignments
Address settings
DNS and Gateway settings
OK
Done

62
Secure your network with Linux distro IPFire


LogMeIn Hamachi
Create Network
Create a new network
Join an existing network
Create
Cancel

68
Turn your home PC into a VPN server for added privacy

70
Build a Ryzen system on a reasonable budget

ZAK STOREY
REVIEWS EDITOR

X99 VS. X370

It's that time of the year again—summer's coming up, and I have the inevitable urge to jump into liquid cooling once more with a brand new system of my very own. I alluded to my copper dreams last issue, but this time I wanted to talk more about the spec. Processor choice, in particular. That's nice to say: choice. It's neat to have choice. AMD or Intel; Ryzen or 2011-3; X370 or X99.

Yep, I'm looking to go with a high-end desktop processor this time around. I need to get myself one of those lairy eight-cores. Naturally, the two choices on hand are AMD's 1800X and Intel's i7-6900K. Both have eight cores, both pack 20MB of cache, and both pump out some phenomenal multi-threaded and single-core performance, given their specs.

The problem for me, however, is chipset. We've spoken in depth this issue about the odd position in which AMD has placed its latest 7 series chips: HEDT performance, with a mainstream chipset. And that's what's giving me pause for thought. Connectivity support isn't enough for what I have in mind on the X370 platform. Couple that with Intel's better thermals, impressive arsenal of motherboards, and more adventurous overclocking experience, and, well, that choice starts to dwindle once more. So, Intel Core i7-6900K and Rampage V, here I come, I guess!

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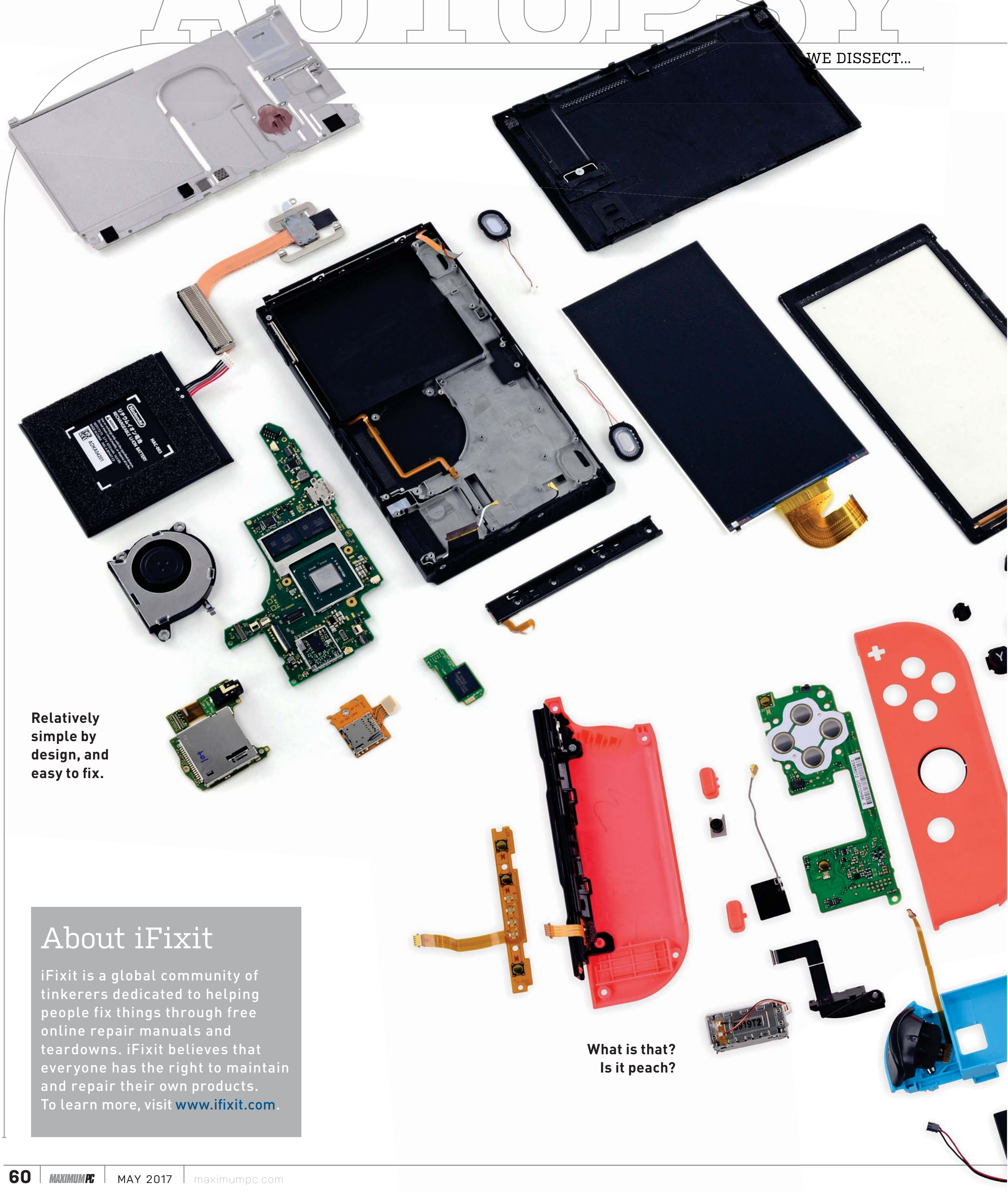


Relatively simple by design, and easy to fix.

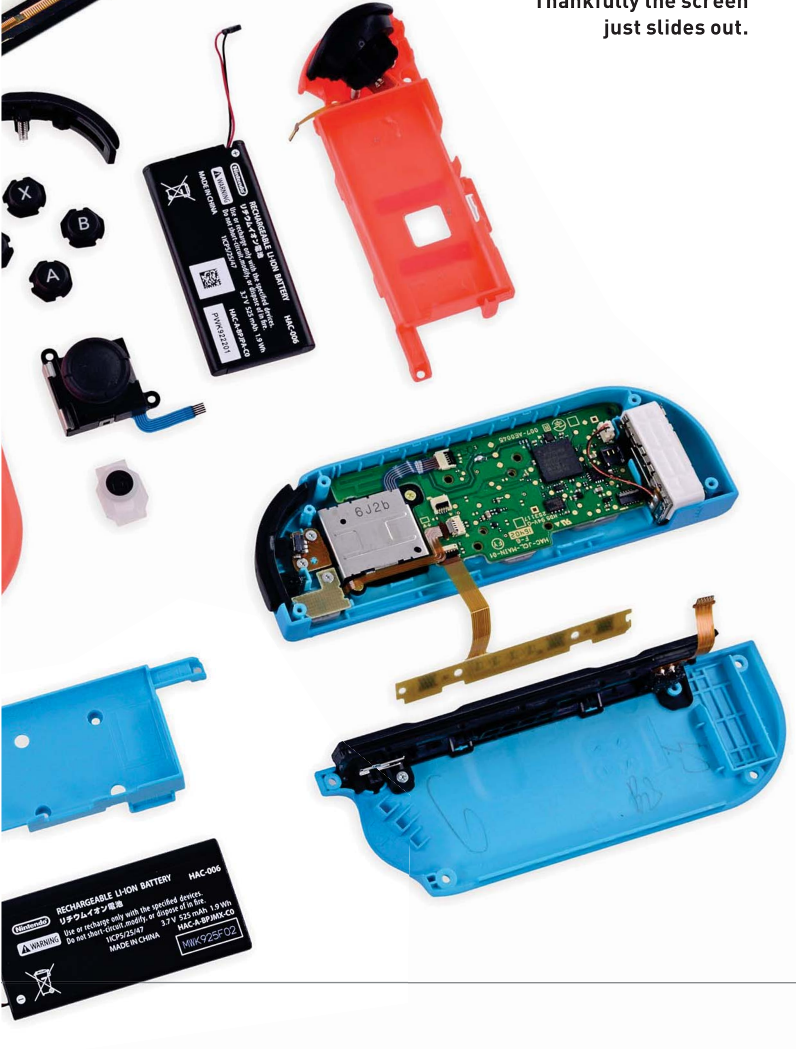
What is that? Is it peach?

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

Nintendo Switch

Thankfully the screen just slides out.



BACKGROUND

Nintendo has finally launched its new console, the Switch. But forget playing games for now—it's time to take a peek at the hardware. Come tear down with us!

MAJOR TECH SPECS

- Nvidia customized Tegra processor
- Built-in 6.2-inch 1280x720 multi-touch LCD screen (capable of 1920x1080 on external display via HDMI)
- 32GB of internal storage (up to 2TB additional storage via microSDHC or microSDXC card)
- 802.11a/b/g/n/ac Wi-Fi, Bluetooth 4.1, USB Type-C charge port, and 3.5mm audio jack on the console, plus three standard USB ports on the Switch Dock
- Stereo speakers
- Rechargeable Li-ion battery capable of 2.5–6.5 hours' play
- Detachable wireless Joy-Cons

KEY FINDINGS

- Disappointingly, tri-point screws guard the entrance, but we only have to flex a tiny bit of muscle. Tri-points are Nintendo's version of a "Keep out" sign, but once past them, the back cover lifts off easily. Our first peek inside reveals little. Just a metal shield. However, once uncased, the modular microSD card board is replaceable. Good news for future storage!
- The heatpipe is secured by Phillips screws, so thermal paste reapplication should be a breeze. We aim for the fan, but it looks like you can only clean it from here—it's trapped under the I/O board. So we pop out the game card reader and attached headphone jack.
- The speakers are lightly adhered to the rear case, but don't put up much of a fight. The larger diaphragms will displace more air, and a ported back allows for booming bass, but reports say they still "favor treble." Phillips screws secure a Joy-Con rail to either end of the console. Each has a set of pin contacts that interlock with contacts on the Joy-Cons to pass charge and button presses to the mobo via ribbon cable.
- And for the cherry on this sundae? The LCD display is easily removable! Increasing a device's portability usually means increasing its likelihood of getting dropped. So way to go, Nintendo, for making a more breakable device more fixable.
- Repairability Score: 8 out of 10 (10 is easiest to repair). Aside from the digitizer, screws are used instead of adhesive. Most components, including the analog sticks, game cartridge reader, and headphone jack, are modular and can be replaced. Batteries, while adhered to their housing, are modular and can also be replaced. The digitizer and display are not fused, reducing the cost of repair, but increasing complexity. Proprietary tri-point screws restrict users from opening the Switch. Replacing a display or digitizer requires heating and prying against strong adhesive.

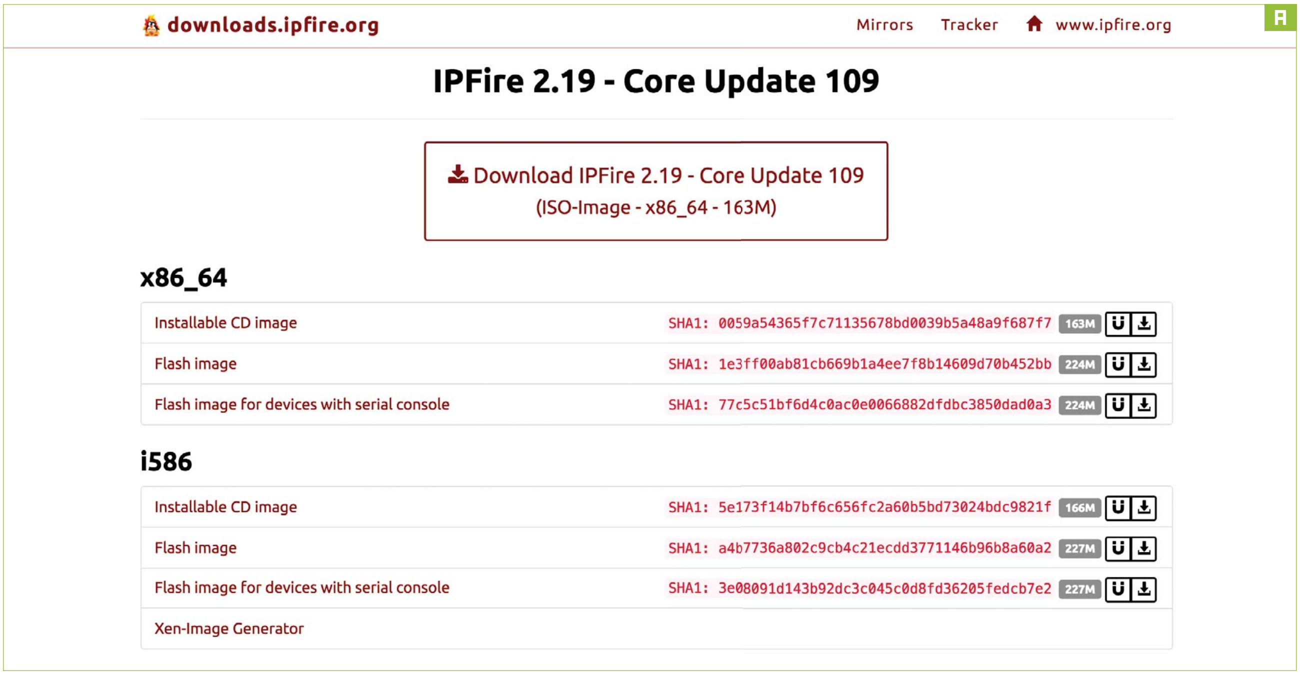
Secure Your Network With IPFire

YOU'LL NEED THIS

IPFIRE
Download the open-source software from www.ipfire.org.

DEDICATED HARDWARE
You need a machine with at least two Ethernet connections.

ALL TOO OFTEN, we take our network security for granted. But leaving the integrity of your Internet connection to your router is tantamount to madness. That's a device most likely selected by your ISP, a company probably not noted for its scruples, to hit the lowest possible price point. It's mass-market hardware, probably not updated in eons, with the associated vulnerabilities and bugs of a machine that's been hammered to death by all the port scans and hacker malice in the world. The good news is that installing a pro-level network appliance on your network is not even slightly difficult; Linux distro IPFire can perform the task very well, as long as you have the requisite hardware. It's not looking for much in terms of specs—an original Pentium will suffice—but you need at least two Ethernet ports. A cheap USB Ethernet dongle should work as an extra port, or at least it did for us. –**ALEX COX**


A

downloads.ipfire.org

Mirrors Tracker www.ipfire.org

IPFire 2.19 - Core Update 109

Download IPFire 2.19 - Core Update 109
(ISO-Image - x86_64 - 163M)

x86_64

Installable CD image	SHA1: 0059a54365f7c71135678bd0039b5a48a9f687f7	163M
Flash image	SHA1: 1e3ff00ab81cb669b1a4ee7f8b14609d70b452bb	224M
Flash image for devices with serial console	SHA1: 77c5c51bf6d4c0ac0e0066882dfdbc3850dad0a3	224M

i586

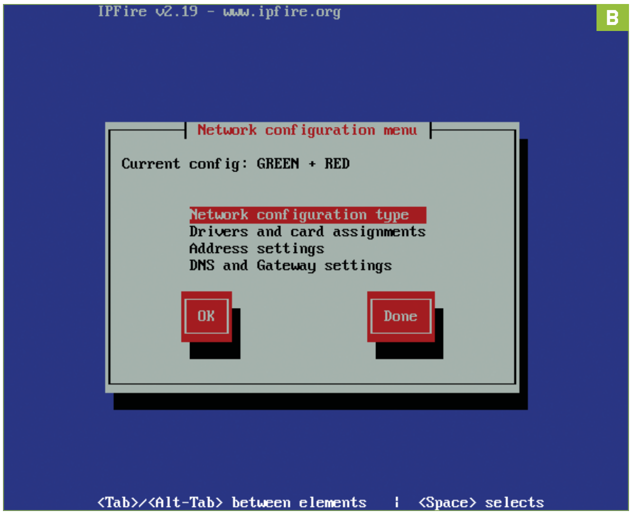
Installable CD image	SHA1: 5e173f14b7bf6c656fc2a60b5bd73024bdc9821f	166M
Flash image	SHA1: a4b7736a802c9cb4c21ecdd3771146b96b8a60a2	227M
Flash image for devices with serial console	SHA1: 3e08091d143b92dc3c045c0d8fd36205fedcb7e2	227M
Xen-Image Generator		

1 GATHER MATERIALS

What exactly are we doing here? We're building a network appliance, which is a piece of hardware that sits on your network and performs specific tasks; your existing router, for example, could be considered a network appliance. An IPFire box doesn't have just one job, though. It's a firewall first and foremost, but we can make it do much more, such as managing DNS and DHCP for our network. To put it in place, you need to have a dedicated PC, cabled between your Internet connection and the rest of the devices on your network. You don't need a mouse or keyboard once it's all sorted, but in order to hook it all up you need at least two Ethernet cables, a machine with two Ethernet ports, and the appropriate version of the IPFire distribution from www.ipfire.org. Make sure you expand the download options [**Image A**] on the site, as we're going to suggest you install this on a USB stick (so grab the disk image version rather than the ISO installer), and if you're running on older hardware (we're firing ours up on a 10-year-old Intel Atom netbook), you may need the 586 or ARM versions, rather than the X64 that's offered up by default. Note that a properly configured pair of VirtualBox virtual machines is adequate for testing IPFire if you don't yet have the requisite hardware; we'll leave that particular configuration as a task for you....

2 GET INSTALLED

Installing IPFire is easier than it might look. Extract the gzipped .img.gz file using something like 7-zip or WinRAR, then write the resulting .img file to a USB drive or SD card using Win32DiskImager (https://sourceforge.net/projects/win32diskimager), ensuring you write to the correct removable device. It's not a tremendously difficult process, and since IPFire generally runs itself from a RAMdisk, there's no need to worry about heavy writes being made to solid-state media. Nonetheless, if you'd rather install IPFire directly, you can do so using the ISO image instead. Boot from whatever media IPFire is installed on, and we can begin initial configuration. Select

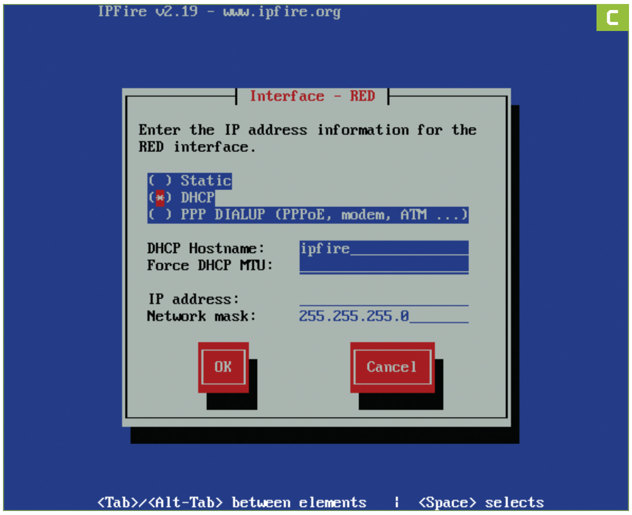

B

```
IPFire v2.19 - www.ipfire.org

         ┤ Network configuration menu ├

 Current config: GREEN + RED

         Network configuration type
         Drivers and card assignments
         Address settings
         DNS and Gateway settings

      OK                          Done

<Tab>/<Alt-Tab> between elements   |  <Space> selects
```

your keyboard, select your timezone, and either give the machine a hostname or stick with the default. You also have to supply a domain name; if you're already running a domain on your network, make sure you input the same name here—running IPFire on a separate domain wouldn't make an awful lot of sense. Now input a root password (and make it a good one, because IPFire is supposed to be your main line of defense), and add a password for the admin user, which has rights to use its web interface, too.

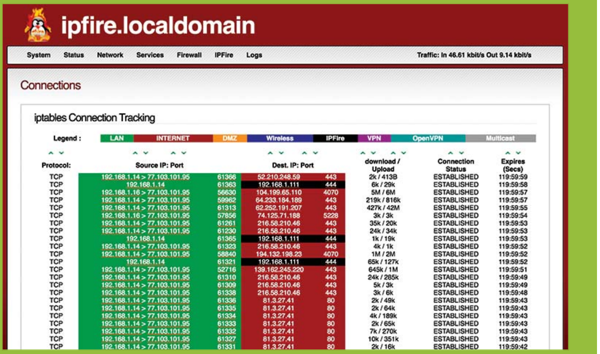
3 NETWORK SETUP

Configuring IPFire's initial network options [Image B] is, frankly, a little intimidating, but there's no need to worry. Pick "Green + Red" under the "Network configuration type" menu (see "Zoning restrictions" on the right to find out what the different colors mean), and use the "Drivers and card assignments" menu to assign one of your Ethernet ports to the red Internet zone, and the other to your green zone, the home of your local network. If you have an identical pair of cards, just choose either one, and be prepared to swap cables between ports if IPFire appears not to work. Head over to the "Address settings" menu, and give the Ethernet adapter connected to your green zone an IP from the local range—we'd go for something along the lines of 192.168.1.1, but the likes of 10.x.x.x and 172.16.x.x are similarly valid. This address is where you'll later access IPFire's web interface, so make a note of it. For your red interface, we're going to presume you're using a broadband connection with a modem that doesn't require any special credentials for access. In this case, just select "DHCP" [Image C], and IPFire takes care of the rest. Lastly, it's time to configure "DNS and gateway settings." Inserting a public DNS server here is optional, but could mean an extra layer of integrity for your connection, and the DHCP server determines which addresses are made available to devices on your network. Make sure your IPFire box is set as the primary DNS, and that everything is running on the same subnet.


C

```
IPFire v2.19 - www.ipfire.org

           ┤ Interface - RED ├

  Enter the IP address information for the
  RED interface.

   ( ) Static
   (*) DHCP
   ( ) PPP DIALUP (PPPoE, modem, ATM ...)

   DHCP Hostname:    ipfire
   Force DHCP MTU:

   IP address:
   Network mask:     255.255.255.0

        OK                  Cancel

<Tab>/<Alt-Tab> between elements   |  <Space> selects
```

ZONING RESTRICTIONS



🟥 RED

Everything outside of IPFire's control is placed in the red zone. Basically, this is its input, probably coming directly from the Internet. Every IPFire setup includes a red zone; if it didn't, there would be no point in using IPFire at all.

🟩 GREEN

Your wired network is designated in the green zone. This area is for devices that fall under IPFire's direct protection, meaning they're subject to your firewall rules and other restrictions. It should, in theory, be a safe network.

🟧 ORANGE

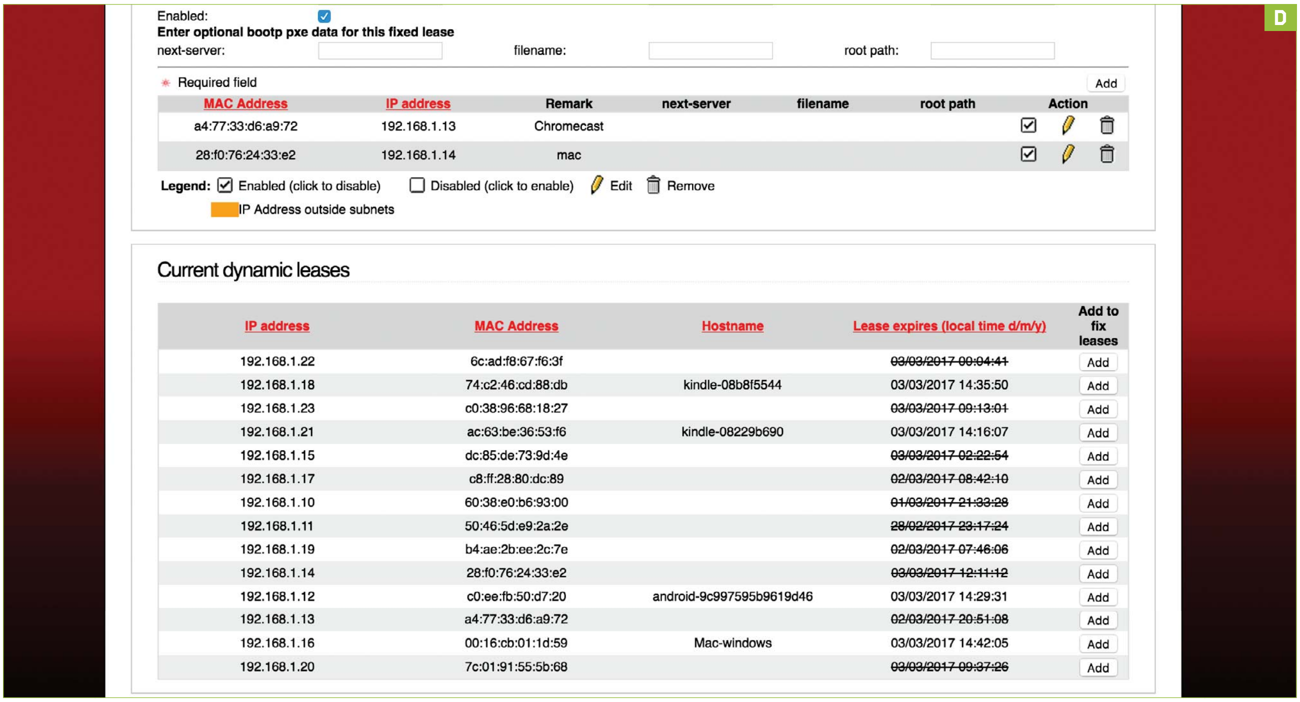
An optional DMZ, or demilitarized zone. If you have servers you want to be web-accessible and excluded from certain network rules, put them in the orange zone.

🟦 BLUE

Wireless devices go here—but bear in mind that you need to use special wireless hardware, and explicitly allow any device that connects to the blue zone. It may be better, for home users, to fudge it on green.

4 HARD FACTS

We're ready to go, right? Not quite. Make sure, if you're attaching IPFire to a combined modem-router, that it's running in router-only mode, because having wireless access before your IPFire installation completely bypasses it, and defeats the object somewhat. Similarly, disable DHCP on any wireless routers you may be inserting into the green zone (we want IPFire to dole out the addresses). And here's a trick that we didn't learn until banging our heads against it for some hours: Don't plug your green zone port into the "Internet" port of your wireless router. Plug it into one of the other ports



Enabled: ☑
Enter optional bootp pxe data for this fixed lease
next-server: filename: root path:

* Required field

MAC Address	IP address	Remark	next-server	filename	root path	Action
a4:77:33:d6:a9:72	192.168.1.13	Chromecast				☑ ✎ 🗑
28:f0:76:24:33:e2	192.168.1.14	mac				☑ ✎ 🗑

Legend: ☑ Enabled (click to disable) ☐ Disabled (click to enable) ✎ Edit 🗑 Remove
🟧 IP Address outside subnets

Current dynamic leases

IP address	MAC Address	Hostname	Lease expires (local time d/m/y)	Add to fix leases
192.168.1.22	6c:ad:f8:67:f6:3f		~~03/03/2017 00:04:41~~	Add
192.168.1.18	74:c2:46:cd:88:db	kindle-08b8f5544	03/03/2017 14:35:50	Add
192.168.1.23	c0:38:96:68:18:27		~~03/03/2017 09:13:01~~	Add
192.168.1.21	ac:63:be:36:53:f6	kindle-08229b690	03/03/2017 14:16:07	Add
192.168.1.15	dc:85:de:73:9d:4e		~~03/03/2017 02:22:54~~	Add
192.168.1.17	c8:ff:28:80:dc:89		~~02/03/2017 08:42:10~~	Add
192.168.1.10	60:38:e0:b6:93:00		~~01/03/2017 21:33:28~~	Add
192.168.1.11	50:46:5d:e9:2a:2e		~~28/02/2017 23:17:24~~	Add
192.168.1.19	b4:ae:2b:ee:2c:7e		~~02/03/2017 07:46:06~~	Add
192.168.1.14	28:f0:76:24:33:e2		~~03/03/2017 12:11:12~~	Add
192.168.1.12	c0:ee:fb:50:d7:20	android-9c997595b9619d46	03/03/2017 14:29:31	Add
192.168.1.13	a4:77:33:d6:a9:72		~~02/03/2017 20:51:08~~	Add
192.168.1.16	00:16:cb:01:1d:59	Mac-windows	03/03/2017 14:42:05	Add
192.168.1.20	7c:01:91:55:5b:68		~~03/03/2017 09:37:26~~	Add

instead. The router might complain about not being able to connect to the Internet but, in our experience, if it's only being used to generate wireless connections, that doesn't matter in the slightest.

5 FRONT END

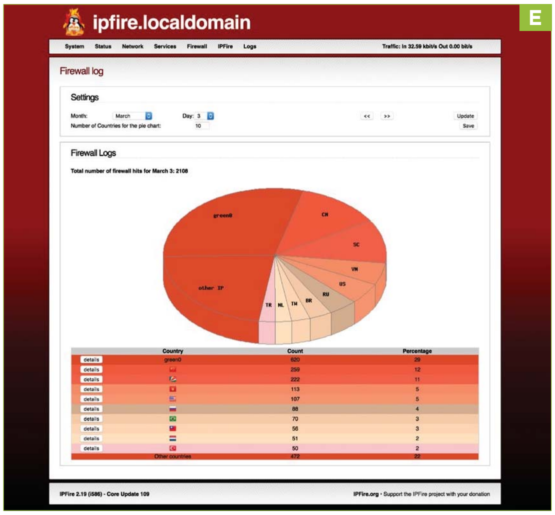
All being well, IPFire should now be up and running. Give everything a reboot (modem, IPFire box, and any network hardware on the other end) just to make sure, then head over to IPFire's web interface, which you'll find either (by default) at https://ipfire.localdomain:444 or, substituting the IP address for the one you gave it earlier, at https://192.168.1.1:444. Log in with the username "admin" and the password you set earlier, and you can start poking around. Take your first look at the "DHCP server" page, in the "Network" section, to check that IPFire is serving up those internal IP addresses successfully—if everything's working, you should see a table of IPs at the bottom of the page. By default, at least if you didn't change the value during installation, each of these addresses is leased for a short amount of time; hitting the "Add" button next to a trusted device assigns it that IP address on a fixed basis [**Image D**]. Knowing exactly where something is can be particularly useful when it comes to troubleshooting your network later on, so it's worth doing. Now, using the "Edit" pencil, you can also change the device's label, if it's not quite obvious enough.

6 BLOCKING OUT

IPFire's place between your Internet connection and your network means it can do some pretty useful things. One of these is web filtering, enabling you to shield tiny eyes from the true horrors of the web. But before you can set that up, you need to enable IPFire's proxy ("Network → Web Proxy"), which is its method of traffic interception. Check the boxes for both "Enable" and "Transparent" on your green network, then check the "URL filter" option on the row below, before scrolling down, and clicking "Save and Restart." Once the page has refreshed, head over to "Network → URL Filter." In its most simple form, you can use the filter to block specific domains and addresses, by inputting them in the custom blacklist boxes, and checking the box below. Alternatively, if you really want to lock down the majority of your network, a whitelist of allowed sites might be more your style. If you earlier gave your main machine a fixed IP address, we recommend adding it to the "Unfiltered" section lower down, so at least one machine on the network maintains full Internet access. There's a further option, too: grabbing a vast list of spurious sites from a pre-built blacklist. You can do this automatically through IPFire's interface (see the "Automatic Blacklist Update" section), but we don't recommend it unless you're running on some muscular hardware—checking every little thing against a massive database can make web surfing miserably slow.

7 FIREFIGHTING

Of course, IPFire's key feature is in its name: its detailed, hardcore firewall. Once you've had it up and running for a while, head over to "Logs → Firewall Logs" to see the kind of thing it's catching in its default state. You'll probably see a lot of "DROP_INPUT" entries, which are



Traffic: In 32.59 kbit/s Out 0.00 bit/s

Firewall log

Settings

Month: March
Day: 3
Number of Countries for the pie chart: 10

Firewall Logs

Total number of firewall hits for March 3: 2108

	Country	Count	Percentage
details	green0	620	29
details	🇨🇳	259	12
details	🇸🇨	222	11
details	🇻🇳	113	5
details	🇺🇸	107	5
details	🇷🇺	88	4
details	🇧🇷	70	3
details	🇹🇭	56	3
details	🇳🇱	51	2
details	🇹🇷	50	2
	Other countries	472	22

IPFire 2.19 (i586) - Core Update 109

IPFire.org • Support the IPFire project with your donation rogue packets that IPFire has successfully deflected, and maybe a few "DROP_NEWNOTSYN" entries on internal devices, which are unavoidable artefacts of a slightly shoddy network stack on at least one of your machines, but absolutely nothing to worry about. If you're interested in the source of any external hits, particularly if something is hammering your network a lot, there are flags to indicate the country of origin, and you can click on any address to do a quick Whois request to find out its owner. Slightly more readable, though less detailed, statistics on the firewall's baddie-thwarting efforts can be found beneath "Logs → FW-Loggraphs" [**Image E**].

8

HARD RULES

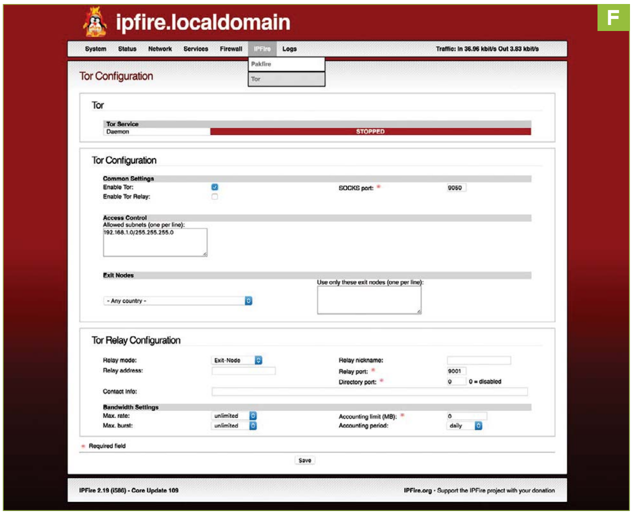
The firewall can be given rules to direct traffic more appropriately, too. Head to "Firewall → Firewall Rules" to see the list, which, by default, is empty; this doesn't mean the firewall isn't doing anything, just that you haven't yet put any exceptions in place. You can go into a huge amount of detail with this, but let's create a quick example rule to designate one of the machines on our network as a web server. Click "New rule." In the "Source" section, click the "Standard networks" radio button, and leave "Any" selected in its drop-down box. Check "Use Network Address Translation," then write the address of your server machine in the box below. Under "Protocol," select "TCP," then set the destination port to 80, the standard port for web traffic. Pop a note on your rule in the "Remark" box, click "Add," and now any web traffic that hits your WAN address goes to your selected machine.

» If you're well endowed with system resources (you need at least 2GB of RAM, and a strong CPU), you can also run an intrusion detection system to analyze packets on your network, and keep you informed of potential attacks. Head to "Services → Intrusion Detection" to switch it on. IPFire uses Snort (www.snort.org) which, while it offers a commercial tier for the most up-to-date rules, is completely free to apply to your network.

9

MAKING ADDITIONS

IPFire's core functionality is pretty comprehensive. Aside from everything we've covered, there's a function to cache Windows updates, so that all machines on your network can get them from your central server, rather than redownloading them ("Network → Update Accelerator"), a service that manages NTP time servers over your network ("Services → Time Servers"), timed access restrictions ("Network → Connection Scheduler"), and built-in VPN facilities ("Services → OpenVPN"), to name but a few. These aren't the limit of what it can do, though. You can install new applications using Pakfire ("IPFire → Pakfire"), which includes a long list of stuff, from console apps, such as htop— see "Command & control" above for more on IPFire's command line—to full-blown add-ons to IPFire's capabilities. Most interestingly to us, you'll find the package tor-x.x.x, which allows us to take advantage of The Onion Router, to add privacy to our network, and even offer it up as a relay, so it can be a routing node or even exit point for other people's traffic. Click it to highlight it, click the blue plus button, then confirm you'd like to install the packages.



Traffic: In 36.96 kbit/s Out 3.83 kbit/s

Tor Configuration

Tor

Tor Service
Daemon STOPPED

Tor Configuration

Common Settings
Enable Tor: ☑
SOCKS port: * 9050
Enable Tor Relay: ☐

Access Control
Allowed subnets (one per line):
192.168.1.0/255.255.255.0

Exit Nodes
- Any country -
Use only these exit nodes (one per line):

Tor Relay Configuration

Relay mode: Exit-Node
Relay nickname:
Relay address:
Relay port: * 9001
Directory port: * 0 0 = disabled
Contact Info:

Bandwidth Settings
Max. rate: unlimited
Accounting limit (MB): * 0
Max. burst: unlimited
Accounting period: daily

* Required field

IPFire 2.19 (i586) - Core Update 109

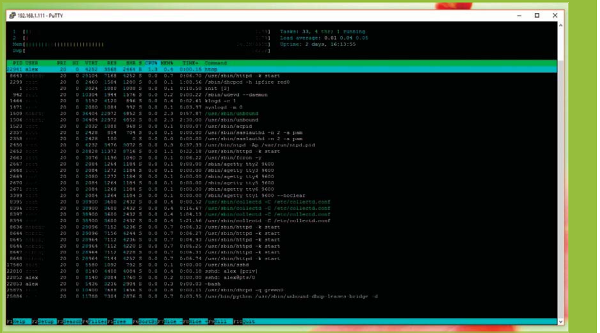
IPFire.org · Support the IPFire project with your donation

10

TOR UP

Once installed, you'll find a new configuration page for Tor at "IPFire → Tor" [**Image F**]. Check the appropriate box to enable the Tor server, optionally select the location of your preferred exit node, then click the "Save" button at the bottom of the page. You can now direct web browsers on your network to use the SOCKS server, on port 9050 of your IPFire box, for pretty-private Internet access. To do this with Chrome, for example, make yourself a new Chrome shortcut, and add the flags `--proxy-server ="socks5://192.168.1.1:9050" --host-resolver-rules="MAP * 0.0.0.0 , EXCLUDE myproxy"` after the executable file, switching the IP address for that of your IPFire box. If you choose to activate a Tor relay, bear in mind that this will probably have a huge impact on your bandwidth, and may be against your ISP's terms of service.

COMMAND & CONTROL


192.168.1.111 - PuTTY
F1Help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice - F8Nice + F9Kill F10Quit

```
Tasks: 33, 4 thr; 1 running
Load average: 0.01 0.04 0.05
Uptime: 2 days, 16:13:55

  PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command
22941 alex       20   0  4252  3568  2464 R  1.3  0.4  0:00.15 htop
 8643            20   0 29104  7168  4252 S  0.0  0.7  0:06.70 /usr/sbin/httpd -k start
 2299            20   0  2460  1504  1200 S  0.0  0.1  1:00.56 /sbin/dhcpcd -h ipfire red0
    1            20   0  2024  1080  1008 S  0.0  0.1  0:10.50 init [3]
  942            20   0 10304  1944  1576 S  0.0  0.2  0:00.22 /sbin/udevd --daemon
 1464            20   0  5152  4120   896 S  0.0  0.4  0:02.61 klogd -c 1
 1471            20   0  2080  1084   992 S  0.0  0.1  0:03.97 syslogd -m 0
 1509            20   0 36404 22972  4852 S  0.0  2.3  0:57.87 /usr/sbin/unbound
 1506            20   0 36404 22972  4852 S  0.0  2.3  2:30.00 /usr/sbin/unbound
 1523            20   0  2032  1080   968 S  0.0  0.1  0:00.07 /usr/sbin/acpid
 2357            20   0  2428   804   704 S  0.0  0.1  0:00.00 /usr/sbin/saslauthd -n 2 -a pam
 2358            20   0  2428   100     0 S  0.0  0.0  0:00.00 /usr/sbin/saslauthd -n 2 -a pam
 2450            20   0  6232  3476  3072 S  0.0  0.3  0:37.33 /usr/bin/ntpd -Ap /var/run/ntpd.pid
 2652            20   0 28828 11372  8716 S  0.0  1.1  0:22.18 /usr/sbin/httpd -k start
 2663            20   0  3076  1196  1040 S  0.0  0.1  0:06.22 /usr/sbin/fcron -y
 2667            20   0  2084  1264  1184 S  0.0  0.1  0:00.00 /sbin/agetty tty2 9600
 2668            20   0  2084  1272  1184 S  0.0  0.1  0:00.00 /sbin/agetty tty3 9600
 2669            20   0  2080  1272  1184 S  0.0  0.1  0:00.00 /sbin/agetty tty4 9600
 2670            20   0  2084  1264  1184 S  0.0  0.1  0:00.00 /sbin/agetty tty5 9600
 2671            20   0  2084  1268  1184 S  0.0  0.1  0:00.00 /sbin/agetty tty6 9600
 3399            20   0  2084  1264  1104 S  0.0  0.1  0:00.00 /sbin/agetty tty1 9600 --noclear
 8395            20   0 38900  3600  2432 S  0.0  0.4  0:00.52 /usr/sbin/collectd -C /etc/collectd.conf
 8396            20   0 38900  3600  2432 S  0.0  0.4  0:16.67 /usr/sbin/collectd -C /etc/collectd.conf
 8397            20   0 38900  3600  2432 S  0.0  0.4  1:04.13 /usr/sbin/collectd -C /etc/collectd.conf
 8394            20   0 38900  3600  2432 S  0.0  0.4  1:21.56 /usr/sbin/collectd -C /etc/collectd.conf
 8636            20   0 29096  7152  4236 S  0.0  0.7  0:06.32 /usr/sbin/httpd -k start
 8644            20   0 29096  7156  4244 S  0.0  0.7  0:06.27 /usr/sbin/httpd -k start
 8645            20   0 28964  7112  4236 S  0.0  0.7  0:04.93 /usr/sbin/httpd -k start
 8646            20   0 28964  7112  4220 S  0.0  0.7  0:06.25 /usr/sbin/httpd -k start
 8647            20   0 28964  7112  4228 S  0.0  0.7  0:06.31 /usr/sbin/httpd -k start
 8648            20   0 28964  7144  4252 S  0.0  0.7  0:06.74 /usr/sbin/httpd -k start
17560            20   0  5580  1092   792 S  0.0  0.1  0:00.00 /usr/sbin/sshd
22810            20   0  8140  4400  4004 S  0.0  0.4  0:00.10 sshd: alex [priv]
22852 alex       20   0  8140  2084  1760 S  0.0  0.2  0:00.00 sshd: alex@pts/0
22853 alex       20   0  5436  3236  2904 S  0.0  0.3  0:00.03 -bash
25875            20   0 10400  7688  1656 S  0.0  0.8  0:00.11 /usr/sbin/dhcpd -q green0
25886            20   0 11788  7304  2876 S  0.0  0.7  0:03.95 /usr/bin/python /usr/sbin/unbound-dhcp-leases-bridge -d
```

Being a Linux distro—albeit a unique one, given that IPFire isn't necessarily built on top of the likes of Debian, Red Hat, et al—you can gain access to IPFire's command-line interface from any machine on your network, once you've switched it on via "System → SSH access." Windows doesn't naturally support SSH, so you need a tool that's happy to connect to it (PuTTY, from www.putty.org, is ideal), and IPFire uses a non-standard port for security reasons, so note that you have to connect to port 222 rather than 22.

Once you're connected, you can do all sorts of handy network things. Try pinging devices on your network by typing `ping <ip address>` or testing your Internet connection by pinging a web address. Take it further, and use the `traceroute` command to see the entire path to a device. Look at what's running on your IPFire box, and exactly what sort of resources it's taking up, by installing htop from the "IPFire → Pakfire" menu, then running `htop` from within the command line. Heck, you could even set up user IDs for everyone in your home, and give them all a Linux shell to play with. It's up to you.

Create Your Own Logo Wallpaper

YOU'LL NEED THIS

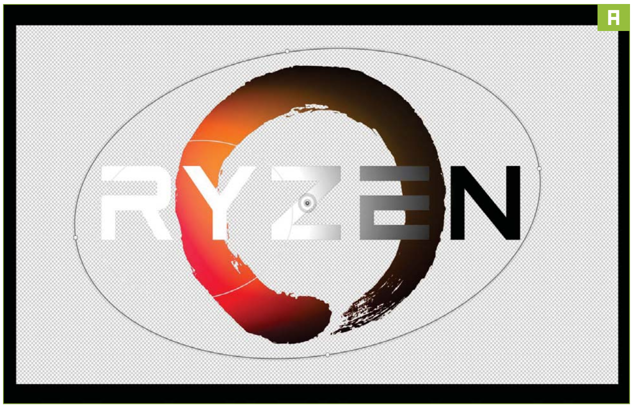
PHOTOSHOP
Available from www.adobe.com.

A LOGO
Pick something that reflects your passions.

YOUR WALLPAPER, OR SCREEN BACKGROUND, is a very personal thing. It's easy enough to place just about any image you want on your desktop with a click of the right mouse button, but you almost immediately get into problems with aspect ratios and resolution—an image that's too small looks terrible when stretched across your monitor.

So, why not make your own? There are lots of reasons why you should, from a cell phone shot being easily high enough resolution and likely the right aspect ratio, to the availability of the stunning photography Microsoft provides in its background packs (we like Reflections and Aurora Borealis). An image that is exactly the pixel dimensions of your monitor is always going to look sharper than one that's had to be altered in some way, and that's what a bespoke wallpaper offers.

If you do decide to make your own, why not brand your PC with some component logos? A lot of our PCs are bespoke designs themselves, after all. In anticipation of an AMD-powered monster emerging from Zak's smoking lab, we did exactly that. –**IAN EVENDEN**

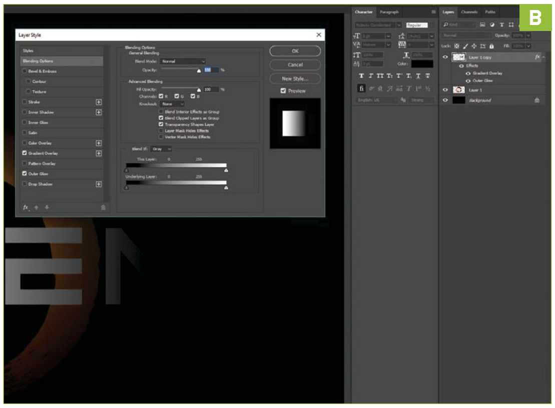


1 LOCATE A LOGO

First, catch your logo. We were lucky enough to score a Ryzen logo as a vector EPS file, which meant we could rasterize it in Photoshop to whatever size we wanted. So we made it 50 x 30cm at 300dpi—a preposterously large size for something that's going to be displayed on a 1440p screen, or a 4K one at a push. The logo touched the edges of the canvas, so we used "Image → Canvas Size" to expand it to 70 x 50cm at 300dpi—over 8,200 pixels across. The logo is floating freely on its own layer, so we don't need to extract it—you'll want to do this if your logo is a .jpg or .png file, in order to fill in behind it. Cut around the logo with one of the marquee tools, or use one of the quick selection tools, then use "Layer → New → Layer Via Copy" to extract it.

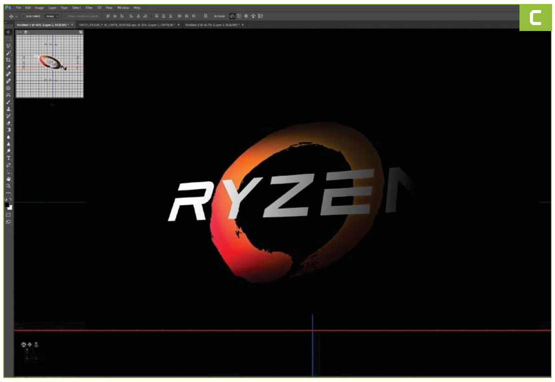
2 ADD SOME LIGHT

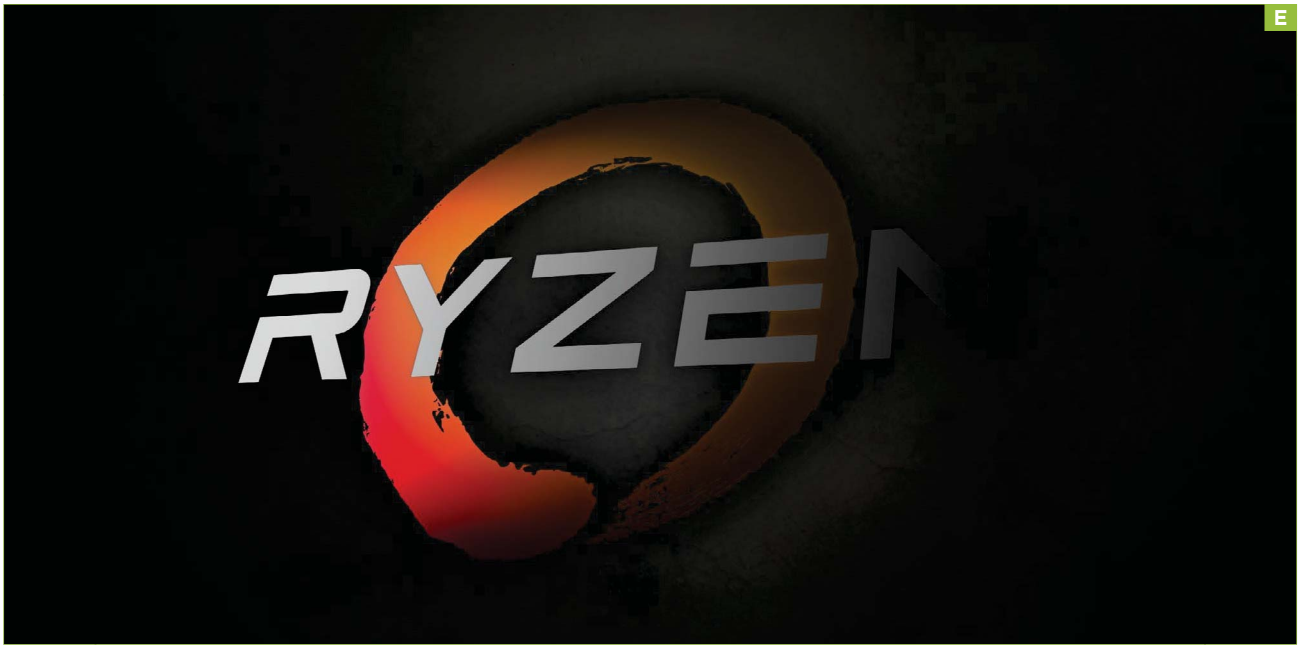
We're seeing AMD in a new light since the launch of Ryzen, so let's cast some new light on the logo [groan!—*Ed.*]. Photoshop's Lighting Effects filter was completely rebuilt for the CS6 release in 2012, so it's one of the newer filters in the application's armory. Lighting Effects enables you to place a directional light on your image, lightening and darkening it to reflect the beam. Select the layer with your logo on it, then head to "Filter → Render → Lighting Effects" to open the filter window [**Image A**]. Mess about with it until you get something pleasing. We've got a spotlight coming in from the right, with its beam constrained so it lights up the left side of the logo's swirl.



3 MAKE IT STAND OUT

The black background behind the logo is just a simple layer filled with black using the Bucket tool—nothing complicated there. Against the black, however, the lettering of the Ryzen logo disappears somewhat, so we're going to use the Magic Wand to select the text, and copy it to a new layer, as detailed earlier. Hide the black layer by removing the eye icon next to it in the Layers palette, to make things easier if you've got a similar black-on-black scenario. To make the lettering stand out, we're going to use some Layer Styles. Double-click the layer to bring up




E

the Layer Styles palette, and add an outer glow and gradient overlay to get the effect we have [**Image B**]. Or play around with what looks good on your image.

4 ADJUST THE ANGLE

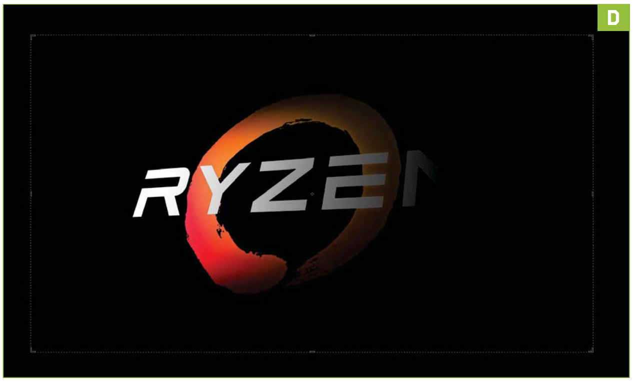
We merged the lettering back into the logo layer by selecting the two layers in the Layers palette and using "Layer → Merge Layers." Keeping this newly created layer selected, we headed to the terrifying "3D" menu, and created a postcard using "3D → New Mesh From Layer → Postcard." A postcard is the simplest 3D mesh Photoshop can produce—it's nothing more than a flat plane, which can have 3D properties attached to it. We're not going to do anything too involved here, just adjust the angle at which the logo sits relative to the viewer, so that's the perfect kind of layer for our needs. Photoshop asks whether you want to change to the 3D workspace from whatever you're currently using—it's worth doing so, just to get a feel for what it's like, but remember to change back once you've finished using the "Windows, Workspace" drop-down at the top-right of the interface.

5 USE THE 3D WORKSPACE

If you're not used to 3D applications, Photoshop's 3D workspace can be a little daunting. You have the three axes around which to move your layer, shown by the small cube with three arrows coming off it in the center, and your cursor changes as it moves across the screen, because it does different things depending on where it's placed. One moment it may be rotating your layer, while a move to the left can change it to one that moves it. The lighting you set up earlier is baked into the layer, and doesn't change as you rotate it around. We simply push the logo around its X axis, so it appears to lean back, then move it back into the center of the composition. A Z-axis rotation puts it at a jaunty angle [**Image C**], and a right-click on the Layer 3 Mesh in the 2D palette brings up a menu from which we select "Rasterize 3D Layer." And the 3D experiment is over.

6 FINISHING TOUCHES

Back in familiar 2D Photoshop, we tell the Crop tool to trim our image to the precise pixel dimensions by inputting them in the fields at the top-left of the interface [**Image D**]. Drag a box on your composition, and you'll see that it's locked to the correct aspect ratio. Click the checkmark once you're happy, and your image is cropped and resized to whatever dimensions you entered. We also decided to spruce up the background a touch with a free texture from http://deviantart.com, layered over the black layer, with a low opacity, and also added a slight gradient to the black layer, to give our final image just a touch more pop [**Image E**].


D

CROP ROTATION

The Crop tool is one of the most useful aspects of Photoshop if you're processing a lot of images quickly by hand—for instance, if you're preparing them for upload to a website's CMS, and they all need to be the same size. By saving presets, you can jump to exactly the pixel dimensions you need, and you can rotate the crop box, too, to make up for any slight variations in level. It's also marked with lines showing the rule of thirds, so you can quickly crop to a more pleasing composition. For more speed, you don't even need to click the checkmark icon—a simple double-click within the area of the crop box applies it.

Turn Your Home PC into a VPN Server

YOU'LL NEED THIS

TWO PCS
One PC should be a laptop.

LOGMEIN HAMACHI
Download it from www.vpn.net.

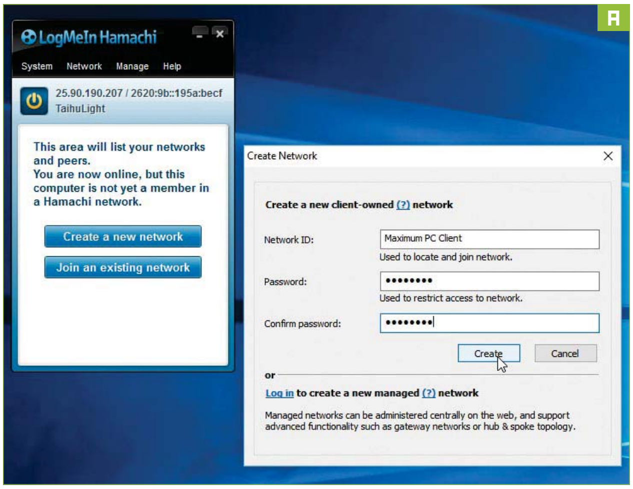
PRIVOXY
Grab it from www.silvester.org.uk/privoxy/Windows.

IF YOU TRAVEL FREQUENTLY—for work or fun—you've probably found yourself in a hotel room or a café with a Wi-Fi password scribbled on a sheet of notepaper and no idea how secure the connection is. Sometimes, you might be able to tether your laptop to your phone, but most plans don't let you make wireless hotspots unless you pay an extra fee, and it's very easy to chew through a whole month's data allowance as Windows decides it's a good time to perform some critical updates.

You can get around this problem by using a PC at home as a proxy server. Rather than data traveling directly from your laptop to the web server, it's sent via a secure encrypted connection to your home PC, which then forwards it.

This technique is only for avoiding eavesdropping on potentially unsecured public networks—it won't hide anything from your ISP. It's also worth noting that your Internet connection speed will be slower than it would be at home—particularly if you're a long way from home when you log on.

We're using a free VPN tool called Hamachi, which is mainly used by gamers to create virtual local networks, and non-caching web proxy Privoxy. Here's how to set it up. –**CATHERINE EMMA ELLIS**



25.90.190.207 / 2620:9b::195a:becf
TaihuLight

This area will list your networks and peers.
You are now online, but this computer is not yet a member in a Hamachi network.

Create Network

Create a new client-owned (?) network

Network ID: Maximum PC Client
Used to locate and join network.

Password: ••••••••
Used to restrict access to network.

Confirm password: ••••••••

or

Log in to create a new managed (?) network

Managed networks can be administered centrally on the web, and support advanced functionality such as gateway networks or hub & spoke topology.

1 PREPARE THE SERVER

This guide requires two PCs: one (a desktop or laptop) to act as the server, and a laptop, which will be the client you're carrying on the road. The server PC must be powered on at all times—something to bear in mind if you're traveling for several days.

›› Using the server PC, download LogMeIn Hamachi from www.vpn.net, and run the software installer. When the program starts for the first time, click the power button to activate it, and you're prompted to create a user account, which is used to manage all your virtual networks and their users [**Image A**]. Do so, then verify it using the link that's emailed to you and re-entering your password. Click "Create a new network," and enter a name and password. The name can be anything you like—Hamachi identifies you using your account and device ID, so this is just for your reference.

2 START SETTING UP THE CLIENT

Now install Hamachi on your laptop, and log in using your account details. You're sent an email notification each time you log in from a new device as a security measure, but you don't need to authorize the connection. Select "Join an existing network," enter the network name and password you created earlier, and click "Join." The name of your desktop PC appears. Right-click it and select "Browse," then enter your usual Windows account login details, and you'll see that you can access the desktop PC's filesystem [**Image B**].

›› If you have trouble connecting to the network, you might need to take a look at Windows' firewall settings, and make an exception for Hamachi. Right-clicking the client PC's name in Hamachi gives you the option of diagnosing network problems, but it doesn't offer any guidance.

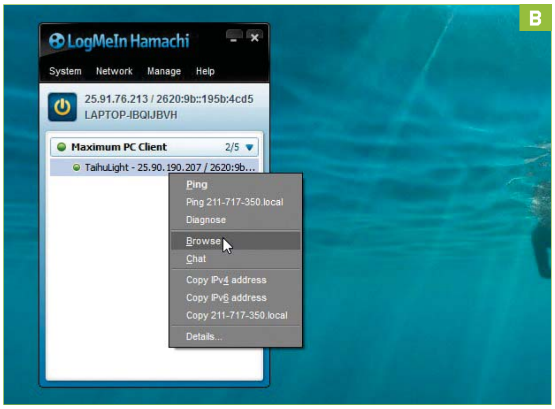
3 CONFIGURE PRIVOXY

Now return to your client PC and download Privoxy from www.silvester.org.uk/privoxy/Windows—the latest stable version of the Windows installer is privoxy_setup_3_0_23.exe. Run the installer, then close the empty window that appears. Privoxy doesn't have a GUI like Hamachi, so right-click the new Privoxy icon in your system tray, and select "Edit → Main configuration" to open the main settings file [**Image C**].

›› Scroll down the text document to section 4.1, and find the line `listen-address 127.0.0.1:8118`. Type a `#` in front of this line to mark it as a comment, then underneath it type:

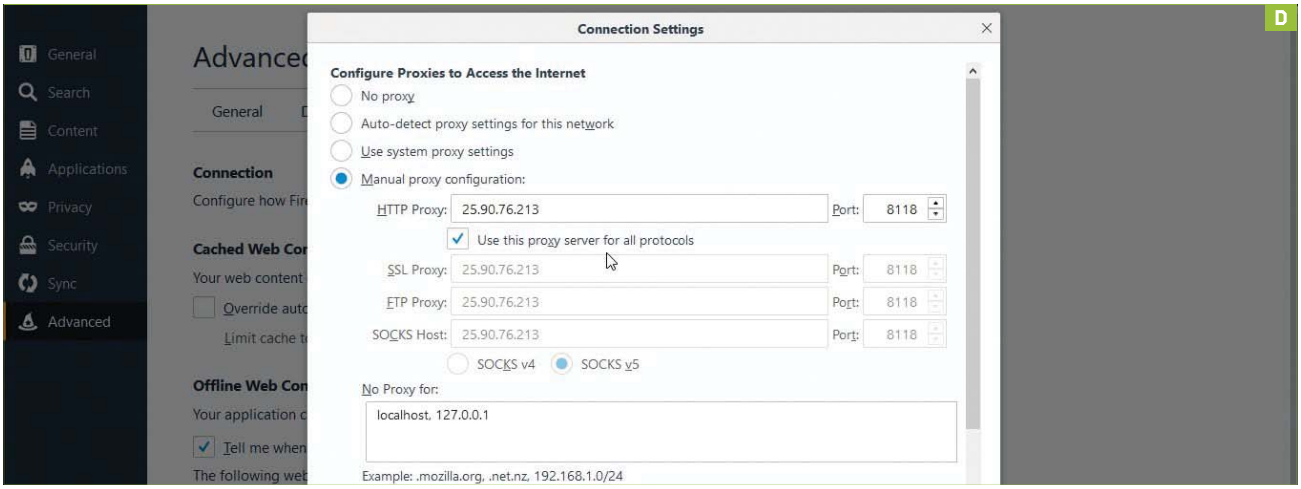
```
listen-address [the IP address at the top of your
Hamachi window]:8118
```

›› Save and close the file. Restart Privoxy. The Windows firewall might prompt you to allow or deny the connection.



25.91.76.213 / 2620:9b::195b:4cd5
LAPTOP-IBQIJBVH

Maximum PC Client 2/5
TaihuLight - 25.90.190.207 / 2620:9b...



Connection Settings

Configure Proxies to Access the Internet

○ No proxy
○ Auto-detect proxy settings for this network
○ Use system proxy settings
● Manual proxy configuration:

HTTP Proxy: 25.90.76.213 Port: 8118

☑ Use this proxy server for all protocols

SSL Proxy: 25.90.76.213 Port: 8118

FTP Proxy: 25.90.76.213 Port: 8118

SOCKS Host: 25.90.76.213 Port: 8118

○ SOCKS v4 ● SOCKS v5

No Proxy for:

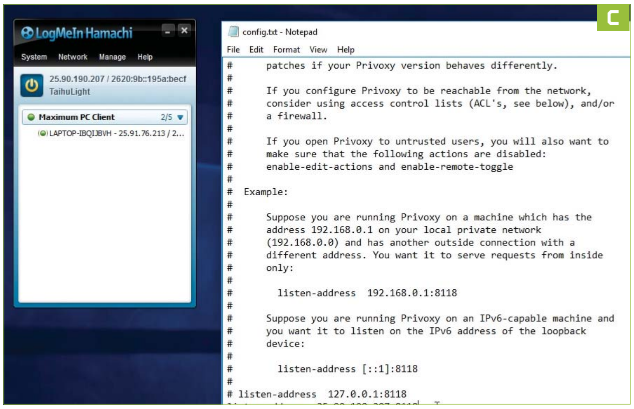
localhost, 127.0.0.1

Example: .mozilla.org, .net.nz, 192.168.1.0/24

4 SET UP YOUR BROWSER

Now you just need to configure your laptop browser's proxy settings to redirect network traffic via Hamachi. In our example, we're using Firefox—open the "Settings" menu, then select "Advanced," click "Connection settings," scroll down to the section on proxies, and use the network address that you entered in the Privoxy configuration file, along with the port number 8118 [**Image D**].

» The process is very similar for most web browsers, though Edge and Internet Explorer use Windows' own networking settings, so all network traffic is routed through the proxy—not just browsing traffic. You might prefer to limit it to your browser, to avoid system updates being downloaded over a slow connection. Browser extensions such as Foxy Proxy (https://addons.mozilla.org/nn-no/firefox/addon/foxyproxy-standard/) make it easy to switch between proxies, and are also worth considering for their added convenience.



25.90.190.207 / 2620:9b::195a:becf
TaihuLight

Maximum PC Client 2/5

LAPTOP-IBQIJBVH - 25.91.76.213 / 2...

```
#      patches if your Privoxy version behaves differently.
#
#      If you configure Privoxy to be reachable from the network,
#      consider using access control lists (ACL's, see below), and/or
#      a firewall.
#
#      If you open Privoxy to untrusted users, you will also want to
#      make sure that the following actions are disabled:
#      enable-edit-actions and enable-remote-toggle
#
#  Example:
#
#      Suppose you are running Privoxy on a machine which has the
#      address 192.168.0.1 on your local private network
#      (192.168.0.0) and has another outside connection with a
#      different address. You want it to serve requests from inside
#      only:
#
#        listen-address  192.168.0.1:8118
#
#      Suppose you are running Privoxy on an IPv6-capable machine and
#      you want it to listen on the IPv6 address of the loopback
#      device:
#
#        listen-address [::1]:8118
#
# listen-address  127.0.0.1:8118
```

» Once it's configured, visit www.privoxy.org/config, and you should see a message informing you that Privoxy is enabled. If so, congratulations—you can now take your laptop away, and connect to the Internet securely via your server PC. If you don't see such a message, the issue is likely to be your firewall settings, or a conflict with an existing proxy that you've forgotten to deactivate.

5 PRIVOXY SECURITY OPTIONS

Privoxy's default settings are fine for getting a secure connection up and running quickly, but the software is also highly customizable. Right-click its icon in the notification panel on your server PC, and select "Edit → User Actions" to tailor its options to suit your Internet use. For example, Privoxy doesn't cache cookies by default, but you can choose to override this for certain sites you visit frequently to avoid having to log in each time. You can also choose whether to exempt some sites from Privoxy's built-in ad-blocking, and filter out annoying page elements. The comments in the file are quite self-explanatory, and you can find detailed instructions at www.privoxy.org/user-manual/actions-file.html.

» To be safe, it's a good idea to make a backup of any configuration files before you change them, so you can easily restore them if any of your changes prevent Privoxy from loading, or stop certain pages working, and you're not sure how to reverse the change. ⏻

OTHER SECURITY OPTIONS

Setting up your own proxy server isn't the only way to secure your browsing when you're away from home. Another option is to use a VPN service, which does the hard work of encrypting the data and redirecting it for you. You can usually choose from a list of servers in locations around the world, which makes it a good way to avoid region-blocking.

There are some free VPNs around, but all of them have strict data transfer caps that make them impractical for anything more than checking a few emails; 100-500MB per day is the standard offering. If you travel frequently, it's worth considering a premium VPN service such as Hotspot Shield Elite, AnchorFree, or TorGuard. This is the only viable option if you want to download large files or stream video over a secure connection, but it's wise to research your options carefully beforehand—some VPNs log more of their users' activity than others, and for different periods of time.

Another option is Tor Browser, which re-routes browser traffic through a network of nodes around the world, not just one server. Its main disadvantage is its slower speed. The data is decrypted at the last node, so there's a small chance that it could be intercepted at this point, but it's otherwise one of the best ways to keep your browsing private and secure.

BUILD IT

ALAN DEXTER, EXECUTIVE EDITOR

Ryzen on a Reasonable Budget

An affordable counterpoint to this month's feature build, we put the Ryzen value proposition to work

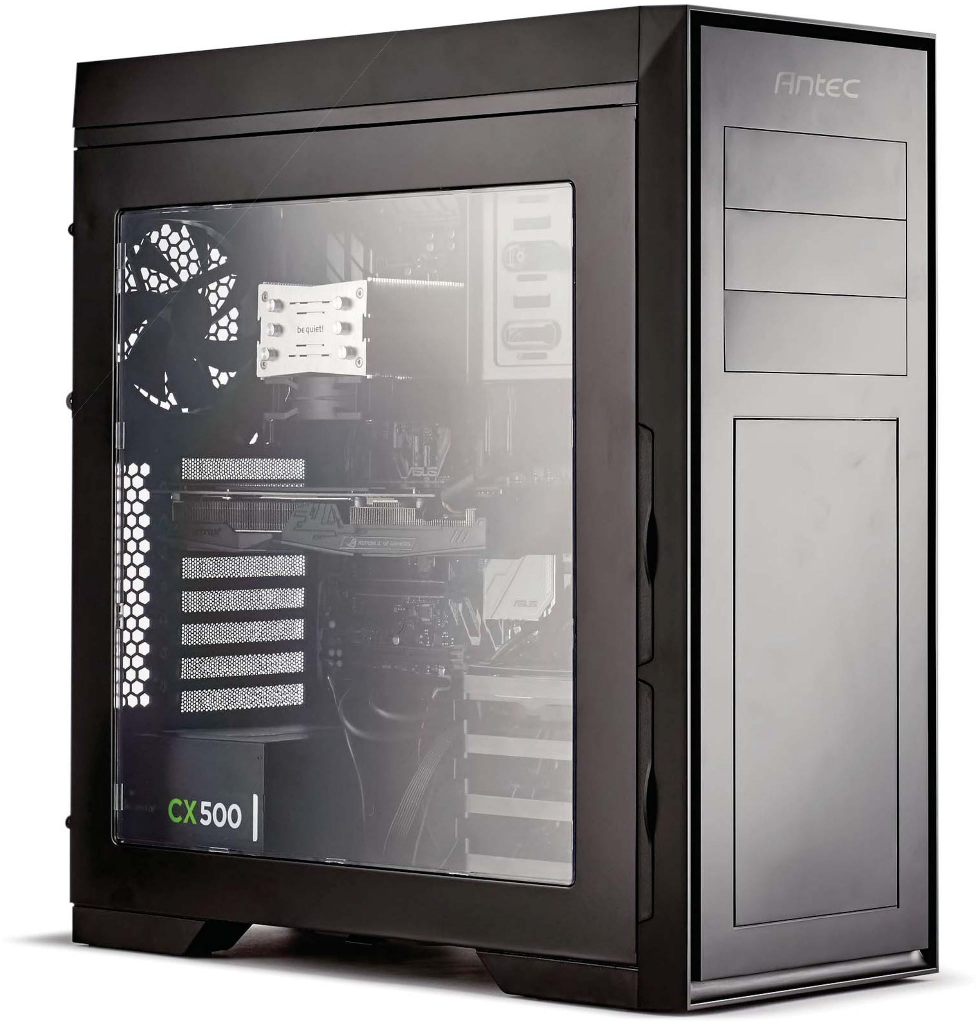
LENGTH OF TIME: **2-3 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

IT'S NOT OFTEN we get to build a machine around a brand new architecture. With the release of AMD's Ryzen 7 chips, though, that's exactly what we've done. In fact, we've done it twice. Turn to page 26, and you'll discover how to build a no-compromise monster, with the top-end Ryzen at its heart. The problem is, that machine rolls in at over $5,000, which puts it out of range of lots of potential system builders. To be fair, there are some liberties with that machine on the storage and memory front, but even so, what if your pockets are not quite so deep? Can you build a decent Ryzen PC for considerably less?

Of course you can, which is why we've dedicated this month's "Build It" to the humble task of seeing what you can do with the most affordable Ryzen chip, the AMD Ryzen 7 1700. This is a mainstream machine that doesn't need a do-anything storage subsystem, or a graphics card that costs more than some entry-level systems. It's a machine that can handle rendering, video editing, and image manipulation, and even turn its hand to a bit of gaming. The kind of system that none of us would be embarrassed to own, even if we might want something with a little more oomph as our main machine.



BUILDING ON A SOLID CORE

THE RYZEN 7 1700 may sit at the bottom of the current Ryzen stack, but it still boasts eight physical cores, and is capable of handling 16 threads at once—it's still designed with heavy lifting in mind. That makes it a fine bedfellow for high-end parts, but what if your needs are less demanding? Or your bank balance less gregarious? That's where this month's build comes in. We wanted a machine that would deliver where it counts, but wouldn't cost the earth, so we've chosen components that offer good value for money, while still helping with overall performance.

One of the first choices is on the motherboard front. At the time of writing, we haven't seen enough AM4 boards to have any definitive answers, but you know where you are with Asus, and the Prime X370-PRO has plenty of features on offer. Likewise, the memory landscape isn't fully formed yet, which means we don't quite know the best kits to recommend right now, so we've picked a kit that has served us well previously.

Given that we want this machine to be an all-rounder, we've opted for an Asus ROG Strix RX 480 to provide the graphical grunt. It's a great card for 1080p gaming, with smooth frame rates in all the latest games. The fact it boasts 8GB of onboard memory means you should have room for games going forward as well.

Note that, after feedback, we now include the cost of the OS in our builds, although you're free to choose whatever OS you want.

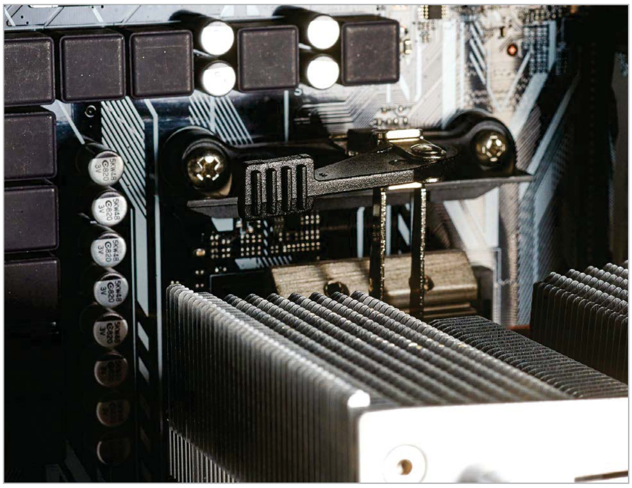
INGREDIENTS

PART		STREET PRICE
Case	Antec P9 Window	**$88**
Motherboard	Asus Prime X370-PRO	**$163**
CPU	AMD Ryzen 7 1700	**$330**
Memory	16GB (2x 8GB) Crucial Ballistix Sport LT	**$130**
GPU	Asus ROG Strix RX 480 8GB	**$220**
PSU	Corsair CX500	**$41**
Storage 1	PNY CS2211 240GB	**$117**
Storage 2	Hitachi Ultrastar 2TB	**$62**
Cooling	Be Quiet! Pure Rock	**$35**
OS	Windows 10	**$100**
Total		**$1,286**

1

EASY MOUNTING

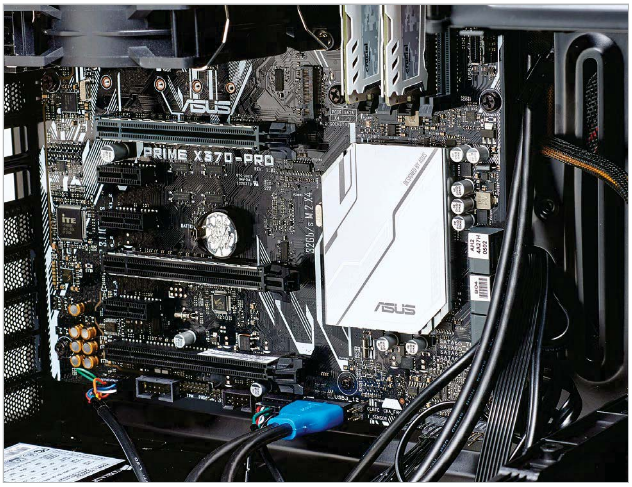
AIR COOLERS TEND to be easier to install than their water-based brethren, because there isn't a radiator on rubber tubes to wrestle with. You do need to watch your fingers on the fins, though, as they have a tendency to shred your fingers in the tight confines of a case—so we recommend installing air coolers outside of the case. AMD's new chips use the AM4 socket, which boasts a similar mounting bracket to the previous generation—a bar stretches across the bottom of the cooler, which you lock into place using lugs on the brackets. Throwing the locking bar over gives you a secure cooler that's easy to release when you need to. The Be Quiet! Pure Rock even comes with a thin layer of thermal paste in place on the underside. Connect the fan, and you're good to go.



2

MOTHERBOARD POINTS

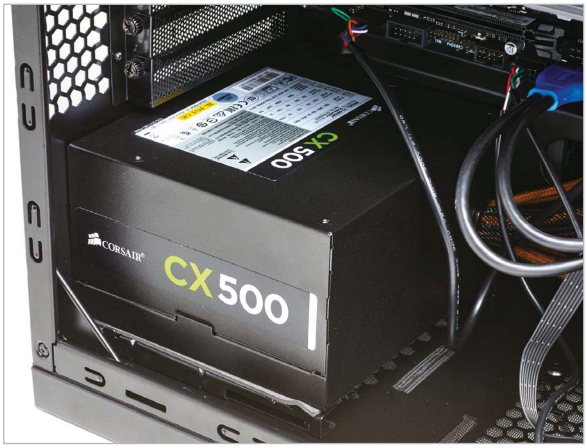
THE ANTEC P9 is a spacious case to work in, with lots of room for routing cables. This means you don't have to install the power supply before everything else. We reached for the motherboard first, noting that the case didn't have all the mounting stand-offs installed by default—they're in a small box, with more cable ties, paper washers, plenty of screws, speaker, and more cables. These are easy to screw in place, and as this is a full-sized mobo, we recommend installing them all. Don't forget to install the ATX backplate before securing the mobo, though, otherwise you'll have to unscrew everything again. Installing memory before sliding the mobo into place is good idea, but you should just have room to add/remove sticks if you have nimble fingers.



3

POWER TIME

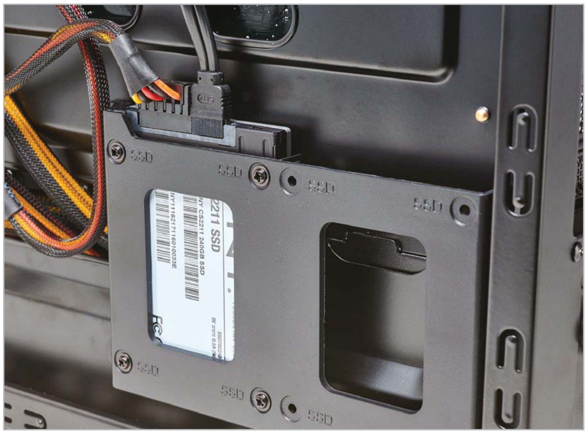
THE CORSAIR CX500 is always a great option if you're trying to build on a tight budget, because it's a quality brand, and has plenty of power for modest builds, but still manages to roll in at a frankly ridiculous $41. It isn't modular, which is hardly surprising at this price point, so you'll have to be creative with your cable management to keep things tidy. We installed the power supply with the fan pointing downward here, and had no problem securing it in place after applying a little pressure on top of the PSU to counter the P9's sponge strips on the PSU bracket, which are designed to help stop vibrations.



4

REVERSE STORAGE

THERE ARE PLENTY of options for your drives in the Antec P9, but the best place to install your SSDs is in the back of the case, in a caddy that can hold two standard SSDs. A pair of screws hold this caddy in place, which makes installation much easier than trying to screw the drives in place with it in situ. The case comes with plenty of screws, so securing our boot drive with four screws makes sense. It's worth noting that as space is a little tight back here, you can't use angled SATA cables, because they come out further than the chassis allows at this orientation. We installed the data drive in the bottom block of cages at the front of the machine, with the cables hidden out of sight.



5

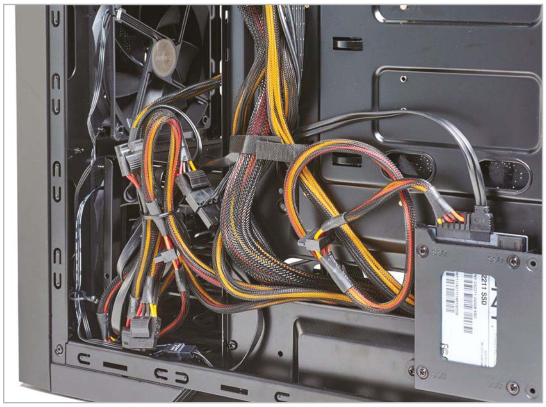
LONG GRAPHICS CARD

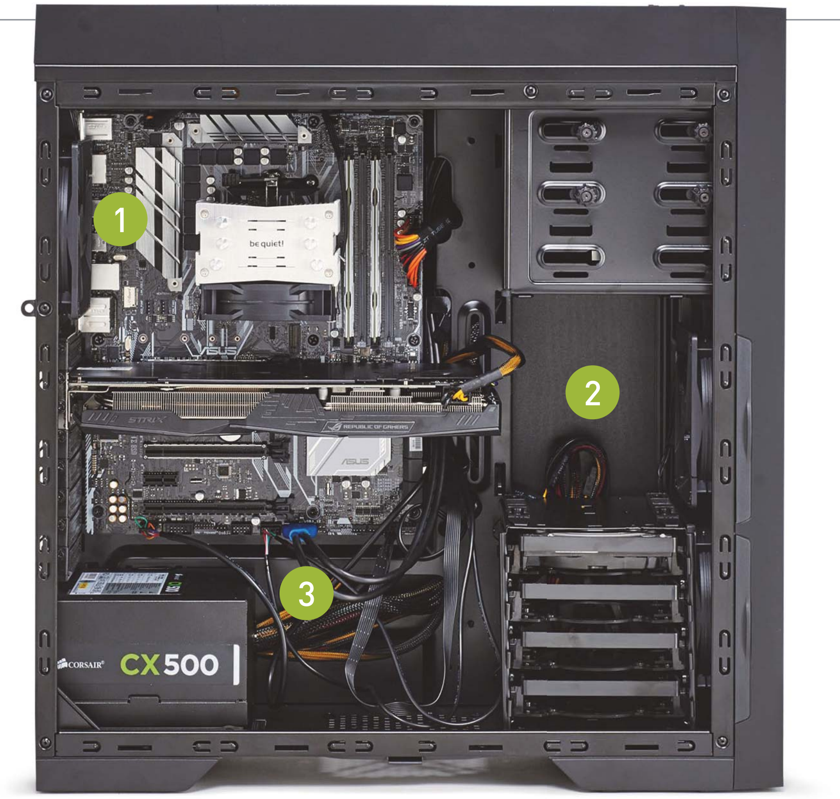
THERE ARE SOME great deals to be had on RX 480s at the moment, and the Asus ROG Strix RX 480 8GB is a good example of what's out there. This triple-fan card boasts higher clocks than the reference cards, but isn't noisy under pressure, which is a boon. Its length can be a problem, though, and indeed wouldn't quite fit inside the Antec P9 until we removed the middle drive bay—a ridiculously easy task that simply requires the releasing of one screw. Once removed, the card eases into place no problem, then it's simply a case of connecting the power cable.

6

TIME TO TIDY UP

ALL THE WAY through this build, we routed as many cables behind the motherboard tray as humanly possible, because this helps with airflow and also keeps the machine looking tidy. It helps that the P9 has plenty of holes to make this a possibility, and there's a central column of cables that you can easily add to as you go. Having said that, there isn't that much room back there, and having a solid central bank of cables isn't possible—well, that's the excuse we're using for this not being quite as tidy as we initially hoped for. We could have used a few more cable ties on the power cables, but ultimately it's a tidy enough build, given we were still trying out different configurations right to the end.





① **The Antec P9 Window comes with three fans installed by default—one at the rear, which covers the main processor block, and two at the front, behind the drive cages. These set up a good flow of air through the system, and we had no problems with heat.**

② **We needed to remove this middle drive cage in order fit the triple-fan RX 480 in place. These cages offer tool-free brackets for up to four hard drives apiece, while the top cage can be home to up to three optical drives—again, tool-free.**

③ **The top of the Antec P9 Window offers a pair of USB 3.0 ports, two USB 2.0 ports, audio connectors, and sliders for easy control over your fans—another neat touch.**

AN AFFORDABLE POWERHOUSE

THERE'S LITTLE DOUBT in our minds that the Ryzen 7 1700 is an incredible chip, and it offers some great opportunities for building systems at a number of price points. Our plan was to build a system that offered strong performance, but was still reasonably priced, and to an extent we hit that main requirement with little hassle. As we're at the very start of a new family of chips, we haven't had chance to try all the different motherboard SKUs yet, and there are some questions over memory performance at this stage, so we'd expect to tweak a mainstream build like this as we find out more, but it certainly shows promise.

Before we say anything else, we'd like to call out the Antec P9 Window for being a great case to build in. For a sub-$100 chassis, it offers plenty of features to make life easier, and while things are cramped in the back, it's better than a lot of cases we've looked at. The tool-free drive cages work well, and removing them couldn't be any easier, should you need to make room for a longer graphics card.

On to performance. Normally we compare our monthly build with our standard desktop zero-point, but that machine costs considerably more than this system, so we've instead compared it to last month's build, which was based on AMD's FX-8370E, and rolled in at roughly the same price.

The differences are impressive, and show just how far AMD has managed to come with Ryzen compared to the outgoing Bulldozer architecture. The Cinebench R15 scores clearly show the advances: The multi-threaded score is to be expected when you're going from an 8-thread chip to one with 16 threads, but it's the single-thread performance that really stands out. That 61 percent improvement shows that this is a significantly different core more than anything else.

The gaming scores aren't as straightforward to interpret, as we're going from a last-gen GTX 960 with 2GB of RAM to a current-generation RX 480 with 8GB of RAM, which costs $60 more. Still, the differences are stark, and in many cases represent a shift from having to dial down settings in order to hit smooth frame rates, to being smooth off the bat. In real terms, you may have to ease back on some settings on newer releases, but this is a machine that will last some time—and if you're serious about gaming, a faster graphics card makes for a wise investment.

Overall, we've enjoyed building this machine, and we're happy with the end result. That hasn't stopped us looking forward to seeing what the rest of the Ryzen family serves up, though—we should have the first Ryzen 5 chips next month, with Ryzen 3 dropping later in the year. We're also intrigued to see what the first Ryzen APUs dish up. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	532	1,401 (163%)
Cinebench R15 Single-Thread	90	145 (61%)
CrystalDisk QD32 Sequential Read (MB/s)	536	560 (4%)
CrystalDisk QD32 Sequential Write (MB/s)	514	456 (-11%)
Deus Ex: Mankind Divided (fps)	15	26 (73%)
Rise of the Tomb Raider (fps)	26	38 (46%)
Far Cry Primal (fps)	35	61 (74%)
Attila: Total War (fps)	20	29 (45%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point PC comparison this month uses an AMD FX-8370E, an Asus GTX 960 2GB, and 16GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

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REVIEWS

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GTX 1080Ti
GEFORCE GTX

NVIDIA GEFORCE GTX 1080 TI
PAGE 76

INSIDE

76 Nvidia GeForce GTX 1080 Ti

78 AMD Ryzen 7 1700X

81 AMD Ryzen 7 1700

82 MSI Aegis Ti3

84 AOC Agon AG352QCX

86 Dell XPS 13 Developer Edition

87 Creative Sound BlasterX Vanguard K08

88 Creative Sound BlasterX Siege M04

89 BitFenix Shogun

90 Torment: Tides of Numenera

91 Tom Clancy: Ghost Recon Wildlands

92 Lab Notes

Nvidia GeForce GTX 1080 Ti

All hail Pascal, the new king… again?

GTX 1080Ti
NVIDIA

A Titan X by any other name.

A YEAR AGO, we reviewed Nvidia's first Pascal card, the GTX 1080. Coming in at $700, it shocked the tech sphere with its exceptional performance. It wasn't just a rebadge, or a meager 10 percent improvement over the previous generation, but a card that took the last-gen Titan X, and threw it to the curb. Nvidia justified the price by saying it was just right for the stunning level of performance. The tech community faltered—a card that would usually cost around $500 was hit by an increase of almost 40 percent.

Fast-forward 10 months, and the ecosystem hasn't entirely changed. Nvidia is still ruling the roost when it comes to those heady graphical heights, and with the developer-focused Titan X coming in at an eye-watering $1,200, for what amounts to a 10–15 percent performance increase over its GTX 1080 sibling, the GTX 1080 was the go-to choice. Until now.

The new GTX 1080 Ti costs $700. Like an odd, red-headed stepchild, it sits eagerly between the GTX 1080 and Titan XP early adopters. Featuring the same full-fat 12 billion transistor-laden GP102 core found in the Titan XP, the Ti also comes with the same 3,584 CUDA cores and 224 Texture Units. The big one, though, is the VRAM, or rather, the butchering that's occurred to that poor Titan's core: 11GB of GDDR5X, instead of 12GB, a 352-bit bus versus a 384-bit memory bus, and, of course, 88 ROPs—eight fewer than the XP. Apart from that, the Ti gets some significant upgrades when it comes to clock speeds. It has a tighter and higher base to boost clock, and also comes packing an 11Gb/s memory clock, versus the rest of the 1000 series's 10Gb/s.

What about performance? In all honesty, it's very impressive. This is the first card we've seen hit near enough 60fps averages in our testing suite at 4K, with all the tests ramped up, hitting 56fps in *Far Cry Primal*, and 55 in *The Division*. *Rise of the Tomb Raider* still tanks fairly low, at console-level frame rates, hitting 29fps, with *Attila* matching at 27, but all in all, it's good.

GPU Boost helps no end, with our particular retail card hitting 1,800MHz on the core clock—almost 300MHz higher than the rated turbo clock. This was a trend that we pushed further in overclocking. Using EVGA's Precision XOC, we managed to bump up the core clocks by an additional 155MHz, and the memory by a staggering 500MHz, leaving us with a max core clock of 2,062MHz, and memory at 6GHz, giving us a total of 12Gb/s bandwidth, leading to a 10 percent improvement in both minimum and average frame rates at 4K, while simultaneously bumping up our Fire Strike figures by almost 2,000 points at 1080p.

All things considered, the GTX 1080 Ti is something of an odd ball. With 11GB of VRAM, and a butchered memory architecture to complement its Frankenstein memory speed, plus that strong overclocking potential, it outperforms a card that essentially costs $500 more, and comes in at the same price that the GTX 1080 cost 10 months ago (that's 50 cents degradation in value per day for the lucky FE owners out there). That said, it's hard to argue against the computational prowess of this phenomenal GPU, and despite the price-gouging Nvidia is arguably leveraging due to the lack of any significant competition, this still, oddly, feels like a good deal. **–ZAK STOREY**

VERDICT
9

EVGA GTX 1080 Ti

+ TI-RIFFIC Solid 4K performance in some titles; great overclocking potential; true single-card solution; decimates 1440p; outclasses Titans.

− TI-RIBBLE Still not perfect 4K card; pricing is dubious.

$700, www.nvidia.com

SPECIFICATIONS

GPU	Pascal
Lithography	16nm FinFET
Transistor Count	12 billion
CUDA Cores	3,584
Texture Units	224
ROPs	88
Core/Boost Clock	1,481/1,582MHz
Memory Capacity & Type	11GB GDDR5X
Memory Speed	11Gb/s
Memory Bus	352-bit
TDP	250W
Display Connectors	DisplayPort 1.4, HDMI 2.0(b)

BENCHMARKS

	Nvidia GeForce GTX 1080 Ti	**Nvidia GeForce GTX 1080 FE**	**Nvidia GeForce GTX 1070 FE**
Total War: Attila (fps)	**14/27**	9/19	6/16
Far Cry Primal (fps)	**51/56**	38/42	30/34
The Division (fps)	**34/55**	19/41	17/33
Rise of the Tomb Raider (fps)	**11/29**	8/20	6/16
3DMark: Fire Strike	**19,616**	17,016	14,909
3DMark: Fire Strike OC	**21,453**	18,115	16,160
$ per Frame	$9.46	$9.68	**$8.64**

Best scores are in bold. Game results are minimum and average fps at 4K. Our test bed consists of a Core i7-6700K and 16GB of DDR4 on an MSI Z170A Gaming M7 motherboard. $ per frame is the average frame rate of all 12 results across three resolutions, split against the price of the cards at time of going to press.

AMD Ryzen 7 1700X
AMD RYZEN

The 1700X is AMD's mid-priced Ryzen chip.

AMD Ryzen 7 1700X

The Goldilocks of AMD's new Ryzen CPU range?

RYZEN IS HERE AT LAST and it's good. You can find out exactly why on page 34. But let's assume you buy into the broader proposition offered by AMD's hot new CPU. You then need to decide between the three eight-core models available from day one.

While AMD has plans for quad-core and six-core variants, they won't appear for several months. In the meantime, it's the launch trio of Ryzen 7 1700, 1700X, and 1800X that demands your attention. The top-drawer 1800X model looks like a marginal proposition in value terms. For a $100 premium, the 1800X buys you 200MHz. That's it. No additional features, no extra cache memory, just a mere five percent uptick in operating frequency, in return for 25 percent more money. Ouch!

At the other end of the scale is the entry-level Ryzen 7 1700. For $329, it looks like a steal for a cutting-edge CPU, with eight cores, and 16 threads. But with a base clock of just 3GHz, and no support for AMD's new XFR automated overclocking feature, those savings come at a price.

So, could the 1700X be the Goldilocks of the Ryzen range—neither too expensive nor too compromised? The clocks come in at 3.4GHz nominal and 3.8GHz Turbo. You get the same 16MB of shared L3 cache as the 1800X, and likewise both an unlocked multiplier for easy overclocking, and the XFR feature. Time to find out what she'll do.

Most impressive is the chip's performance in highly parallel workloads, such as content creation, media encoding, that sort of thing. Somehow, AMD's engineers have come up with a simultaneous multi-threading technology that's even more efficient than Intel's Hyper-Threading. The result is that this eight-core chip monsters tasks like video encoding or professional image rendering.

For those kinds of jobs, this mere $399 chip is roughly on a par with Intel's $1,000 Core i7-6900K beast. Meanwhile, it utterly obliterates the best of Intel's CPUs for the mainstream LGA1151 socket, the $350 Core i7-7700K. Following that initial victory, the picture becomes more nuanced.

SINGLED OUT

In anything single-threaded, this chip isn't quite such a killer. Depending on what Intel CPU you care to compare it with, you're looking at a performance deficit of anywhere from around 10 to 20 percent. Roughly 10 percent of that is down to AMD's Zen architecture not being quite as powerful on a per-core and per-clock basis as Intel's latest CPU designs. The other 10 percent is thanks to clock speeds that are just a little off Intel's pace.

Speaking of clock speeds, one notable disappointment with all Ryzen CPUs we've seen is moderate overclocking headroom. With an official Turbo speed of 3.8GHz, you might think 4GHz or more is on the cards, courtesy of that unlocked multiplier. Sadly not. Our sample chip could only keep its act together at 3.9GHz, making for an overclock of just 100MHz. AMD's snazzy new XFR automated overclocking feature couldn't do any better, either. That said, in testing at stock settings, our 1700X ran at 3.5GHz during heavily threaded workloads. In other words, 3.9GHz represents more like a 400MHz overclock in the real world.

However, Ryzen's most obvious weakness involves gaming. The precise reasons are unclear. Very likely, the fact that no existing PC games are compiled and optimized for what is a brand new CPU architecture is at least partly to blame. But there's no denying the 1700X sometimes struggles to keep up with Intel CPUs in games. Most of the time, that's moot. Whether you're getting 120 frames per second or 150 is academic. But in those few titles that really make heavy demands of your CPU, it could be the difference between smoothness and stutter. Of course, if you don't game, that hardly matters. For everything else, this is one hell of a CPU. –**JEREMY LAIRD**

VERDICT

9

Ryzen 7 1700X

+ **GOLDILOCKS** Stunning multi-threaded performance; super-aggressive pricing; fully unlocked.

− **BIG BAD WOLF** Minimal overclocking headroom; patchy gaming performance.

$399, www.amd.com

BENCHMARKS

	AMD Ryzen 7 1700X	AMD Ryzen 7 1800X	Intel Core i7-7700K
X265 Benchmark (fps)	26.81	**27.89**	20.68
Cinebench R15 Single/Multi (Index)	154/1,542	159/**1,612**	**194**/970
FryRender Benchmark (m:s)	2:52	**2:41**	3:45
Power Draw Idle/Load (W)	57/143	56/182	**44/110**
Total War: Attila @ 1440p (fps)	39	39	**41**
Far Cry Primal @ 1440p (fps)	74	75	**77**
Rise of the Tomb Raider @ 1440p (fps)	**43**	**43**	**43**
Deus Ex: Mankind Divided @ 1440p (fps)	**13**	**13**	**13**

Best scores are in bold. Our test bed consists of an Asus Crosshair VI Formula, 16GB of DDR4 @ 2,666MT/s, an Nvidia GTX 1080, and a Samsung 850 Evo SSD. Games are tested on the highest possible preset @ 1440p.

SPECIFICATIONS

Base/Turbo Clock	3.4GHz/3.8GHz
Cores/Threads	8/16
Lithography	14nm
Cache	16MB
Memory Support	DDR4 2,666MT/s
Memory Channels	2
Max PCIe Lanes	16+4
Graphics	N/A
TDP	95W

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AMD Ryzen 7 1700

Is this the new ruler of the value performance realm?

BREAKING THE NORMS of price to processing power is something AMD has progressively done with its Ryzen series of CPUs. Its 1800X and 1700X have dominated our testing suites recently, demolishing the competition. But both of those feel like mere footnotes in contrast to the sheer power AMD has managed to leverage into the core complexes buried at the heart of its Ryzen architecture.

We've repeatedly said that the 1800X and 1700X fall a little flat when it comes to overclocking, with the 1800X managing a meager 300MHz overclock, at most, on all of its cores, and the 1700X just a touch higher than that. Not too impressive for a chip with a 95W TDP. That said, for the price, and in contrast to their blue counterparts, both chips are simply staggering.

The 1700, then, makes the 1800X look like a kitten in comparison. Differences are few and far between: You lose out on the XFR (extended frequency) SenseMi software, which boosts a couple of cores higher, depending on your cooling solution, and the core clocks are far slower than either the 1700X or 1800X, coming in at a still respectable 3GHz, with a 3.7GHz turbo (only on four cores), but the 1700 has only a 65W TDP, as opposed to the 95W pumped into its power-hungry compadres.

By default, the performance figures are pretty solid—24.12fps in our X265 benchmark and 1,406 in Cinebench put this core in 6900K territory, a processor that comes in at a whopping $720 more. The thing is, this core doesn't stop there. All of Ryzen's lineup is overclockable on any X370 or B350 motherboard—and, holy cow, does this chip overclock! We managed to bump all eight cores up to 3.9GHz, with very little trouble. Temperatures peaked at around 65 C under load, utilizing the NZXT Kraken X62, but what was more amazing was the fact that it even outperformed the the 1800X, while simultaneously drawing less power and running cooler (even allowing for AMD's erroneous 20-degree temperature boost).

Bumping the core clock up to 3.9GHz (bearing in mind that there have been reports of many hitting 4.1GHz under water), we saw an improvement of 18 percent in Cinebench R15's multi-threaded test, 7 percent in single-core performance, 20 percent in our X265 benchmark, and a 10 percent improvement in Fryrender, too. Which, let's face it, is truly incredible for a core that costs $330—20 bucks less than a Core i7-7700K.

So, is it all a bed of roses? Not quite. Our sample was plagued by memory issues. Testing across multiple motherboards and memory kits, we struggled to get any to operate beyond 2,133MT/s. After speaking to AMD and running multiple tests, we came to the conclusion that our particular sample was damaged, so we wouldn't expect to encounter the same problems with other specimens.

Generally speaking, Ryzen's memory support isn't perfect just yet, and, yes, there are scheduling issues, but these are all to be expected with a brand new architecture design. Look back several years to Nehalem, and the birth of Intel's core architecture, and you can see the same issues occurring there, too. Ultimately, however, teething issues aside, this chip is nigh on godly, and if we could give it a 10, we would. **–ZAK STOREY**

BENCHMARKS

	AMD Ryzen 7 1700	AMD Ryzen 7 1700 OC	AMD Ryzen 7 1800X	Intel Core i7-7700K
X265 Benchmark (fps)	24.12	**29.09**	27.89	20.68
Cinebench R15 Single/Multi (index)	147/1,406	157/**1,659**	159/1,612	**194**/970
Fryrender Benchmark (m:s)	2:58	**2:40**	2:41	3:45
Power Draw Idle/Load (W)	47/115	53/145	56/182	**44/110**
Total War: Attila @ 1440p (fps)	35	37	39	**41**
Far Cry Primal @ 1440p (fps)	73	73	75	**77**
Rise of the Tomb Raider @ 1440p (fps)	**43**	**43**	**43**	**43**
Deus Ex: Mankind Divided @ 1440p (fps)	**13**	**13**	**13**	**13**

Best scores are in bold. All benchmarks were performed on the Asus Crosshair VI Hero AM4+ motherboard, with 16GB of Corsair Dominator Platinum memory at 2,400MT/s, and an Nvidia GTX 1080.

VERDICT
9
KICK ASS!

AMD Ryzen 7 1700

➕ **REALLY GOOD** Price; performance; overclocking potential; power draw; solid gaming performance.

➖ **STILL REALLY GOOD** Some early adopter teething issues.

$330, www.amd.com

SPECIFICATIONS

Base/Turbo Clock	3GHz/3.7GHz
Cores/Threads	8/16
Lithography	14nm
Cache	L3 16MB
Memory Support	64GB DDR4
Memory Channels	2
Max PCIe Lanes	16+4
TDP	65W

MSI Aegis Ti3

Mean machine makes a mega impression

WE'VE TAKEN TO calling the Aegis Ti3 "Optimus Prime" around the office, though perhaps "Megatron" is more appropriate. With angular features and red and black styling, the Aegis Ti3 looks more Decepticon than Autobot, but we can't hold that against it—especially considering the power locked inside.

The Ti3 marks the third generation of MSI's Aegis gaming desktops, and this iteration updates the system with an Intel Kaby Lake processor—a 4.2GHz Core i7-7700K, with the turbo raised from 4.5 to 4.8GHz. Also slotted in the MSI Z270 motherboard is a ludicrous 64GB of DDR4-2400 RAM—an absurd amount that's more than enough for any pile of tasks you might have in mind. The result is solid scores in Cinebench R15 (1,032) and Tech ARP's x264 (23.22fps), though that latter number comes with a caveat, because x264 crashed the first few times we tried running it. Apparently, the factory CPU bump was only done to the clock speed, not the voltage, resulting in some instability under heavy load. It was only after bumping the voltage up a tad that the test completed without a hitch.

On the storage front, a pair of M.2 drives in RAID 0 amount to 1TB of NVMe SSD space for all your games, programs, and OS, while a 3TB HDD takes care of media cold storage. But what the SSDs have in sheer size, they lose in performance, falling short of our zero-point in CrystalDiskMark x64's 4K read and write tests. PCMark 8 Creative wasn't too affected by the drive access though, producing a healthy overall result of 9,489—beating our zero-point by a significant margin.

TRANSFORM YOUR GAMING

Productivity benchmarks are all well and good, but the Aegis Ti3 is a gaming system first and foremost. To prove it, pixel-pushing is handled by a pair of GTX 1080s in SLI. We've had some issues with SLI performance in the past—especially at 1080p—but things have gotten considerably better recently due to updated drivers. We performed testing on Nvidia's 378.78 drivers, which added SLI profiles for a handful of games, as well as optimizations for DirectX 12. The latter proved considerably helpful in *Rise of the Tomb Raider,* where we've often found dual-GPU systems to perform better at 1080p with SLI disabled.

Not so this time. With DirectX 12 enabled, the Aegis Ti3 landed some of the best scores we've ever seen in *Rise of the Tomb Raider.* At 1080p max settings, the Ti3 averaged 166fps across the game's three-part benchmark (219fps mountain peak, 144fps Syria, 133fps geothermal valley). 1440p and 4K performance was just as impressive, averaging 151fps in the former and 87fps in the latter—both at max settings. *The Division* fared similarly, with 140fps at 1080p, 105 at 1440p, and 65 at 4K. Those numbers were without DirectX 12, though, because enabling it resulted in knocking our frame rates down by around 30 percent.

Far Cry Primal was a different story. Continuing to be one of the most difficult games to land a high frame rate at lower resolutions, the game scored almost exactly the same at 1080p and 1440p max settings: 88 and 87fps respectively. 4K wasn't much below that either, with 72fps—again, with settings at the highest preset. Finally, 3DMark Fire Strike returned excellent scores: 24,134 for the regular 1080p test, 16,074 at 1440p, and 9,115 in the 4K gauntlet of Fire Strike Ultra.

All told, the Aegis Ti3 is an incredibly capable gaming machine, with aggressive styling to match. The slanted case is a bit odd to look at, but it's actually quite compact (20.1 x 19.9 x 6.7 inches) considering how much is inside. The carrying handle is a nice touch, too, making the system easy to tote, despite its weight (31.5lb). But hopefully you're happy with the insides—according to stickers on the back panel screws, opening the case violates the warranty. **–BO MOORE**

VERDICT **9**

MSI Aegis Ti3

⊞ **AUTOBOT** Outstanding gaming performance; tons of storage; surprisingly slim.

⊟ **DECEPTICON** Storage not the fastest; unstable factory CPU overclock; opening it voids the warranty.

$4,300, www.msi.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 (Index)	987	1,032 (5%)
Tech ARP x264 (fps)	21.93	23.22 (6%)
PCMark 8 Creative (Index)	7,675	9,489 (24%)
CrystalDiskMark 4K Read (MB/s)	54.85	46.53 (-15%)
CrystalDiskMark 4K Write (MB/s)	171	153.7 (-10%)
Far Cry Primal (fps)	76	88 (16%)
The Division (fps)	78	140 (79%)
Rise of the Tomb Raider (fps)	41	166 (305%)
3DMark Fire Strike (Index)	15,026	24,134 (61%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point has a Core i7-6700K overclocked to 4.6GHz, an XFX Radeon R9 Fury X, 32GB of Kingston HyperX Savage DDR4-2400, and a 256GB Samsung 950 Pro, mounted on an Asus Z170i Pro Gaming mobo.

SPECIFICATIONS

Processor	Intel Core i7-7700K @ 4.2GHz
Graphics	2x MSI GeForce GTX 1080 Gaming in SLI
RAM	64GB DDR4-2400 (4x 16GB)
Motherboard	MS-B912 Military IV (Z270)
Primary Storage	1TB (2x 512GB) M.2 NVMe SSD
Additional Storage	3TB SATA HDD
Cooling Solution	Silent Storm Cooling 3 Pro with liquid cooling
PSU	850W 80 Plus Platinum
Case	Aegis Ti3 chassis
Warranty	Two-year manufacturing warranty, with on-site pick-up and return service

The Aegis Ti3 backs up its aggressive gamer styling with top-notch performance.

AOC's latest gaming panel looks preposterous on paper.

AOC Agon AG352QCX

High-refresh Hz meets low-res hurts

NOT LONG AGO, the basic premise of this new AOC panel would have been preposterous. Measuring 35 inches diagonally, with a superwide 21:9 aspect ratio, and capable of no fewer than 200 refresh cycles per second, along with frame-synching technology in the form of AMD's FreeSync, it's an absolute monster. It's curved, too, and sports VA panel technology.

So, it says a lot about how far things have moved on in the last 18 months that not only has much of the above become, if not mainstream, then at least unremarkable, but we are also balking at one particular specification: The new AOC Agon AG352QCX gives you a mere 2560x1080 pixels.

Again, a few years ago, that would have been impressive. Today, and especially with a panel this large, on which you might expect to see 3440x1440 pixels, it looks a bit puny. To put it another way, the net result is pixels that look pretty fat. Putting a precise number on that, it works out at 79 pixels per inch. In a world where a mid-range smartphone packs nearer 300 pixels per inch, and a 27-inch WQHD display offers 50 percent more, this new AOC is at a disadvantage. But hold that thought while we consider its broader qualities.

It looks impressive, physically, as it ought to for the money, even if the gamer-centric LED lighting is a little adolescent for some tastes. The stand is also fully adjustable, bar the facility to rotate from landscape to portrait—understandable, given its ultra-wide form factor.

As for image quality, pixel pitch aside, it's a mixed bag. The use of VA rather than IPS panel technology would normally have you expecting some seriously saturated visuals. But the truth is that this panel lacks punch. Yes, there's good detail in both black and white scales and the objective contrast performance, as indicated by a claimed static ratio of 2,000:1. But quite a bit of banding is visible in gradients, the viewing angles aren't as expansive as the best IPS panels, and various degrees of ghosting are visible, depending on how you set the overdrive option in the OSD menu. That's not a huge surprise, given the pixel response is the weakest attribute of any VA monitor, but it is an issue for a monitor primarily pitched at gamers.

Speaking of which, this monitor still makes most sense for gaming. While the native resolution translates into relatively ugly font rendering and limited desktop space, it also means less load on your GPU. That means better frame rates, and it gives you half a chance to make the most of what is perhaps this monitor's biggest selling point: a 200Hz refresh rate.

That's a big number, and immediately begs the question of whether one can truly tell the difference between, say, 120Hz and 200Hz. The answer is that each person has different sensitivities to refresh rates, but, yes, we could tell the difference. The smoothness and stability of a monitor running at 200Hz is undeniably something special. However, even with a very powerful video card, and factoring in the relatively modest native resolution, achieving anything like 200fps in the latest games is fairly fanciful.

You do, of course, have the FreeSync technology to fall back on, adding smoothness at lower frame rates, but that's limited to AMD video cards, and doesn't make the 200Hz feature any more relevant. All of which means the AOC Agon AG352QCX is an unusual mix of flaws and nevertheless-compelling features. Were it a little cheaper, it would probably carve out its own niche, but it's pretty pricey, so it's a fairly hard sell. **–JEREMY LAIRD**

VERDICT
7

AOC Agon AG352QCX

➕ **WARP SPEED** 200Hz refresh is lovely; 35-inch and 21:9-aspect panel really fills your field of view.

➖ **CORE FAILURE** VA panel delivers disappointing image quality; relatively low resolution makes for fat pixels.

$780, www.aoc.com

SPECIFICATIONS

Panel Size	35-inch
Native Resolution	2560x1080
Pixel Density	79 ppi
Panel Type	VA
Maximum Refresh	200Hz
Response	4ms
Contrast	2,000:1
Display Inputs	DisplayPort, HDMI, VGA
Connectivity	USB
VESA Mount	100 x 100mm
Warranty	Three years

Dell XPS 13 Developer Edition

Dell's updated Linux laptop—we wish we were richer

DELL'S XPS 13 LINEAGE, now in its sixth generation, has long been regarded as the pinnacle of svelte laptops. When they first appeared in the wild, people were amazed that such a finely crafted product could be made outside of the fruity confines of Infinite Loop. Over its lifespan, Dell has tweaked the design, updated the hardware, and, back in 2015, added the Infinity Edge display. This made a rather tempting piece of hardware extremely so—who can resist the non-Euclidean charms of a 13-inch display fitting inside an 11-inch case? Especially when said display is a beautiful QHD+ touch affair. Aesthetics aside, Dell's other trick here has been its support of Linux on its hardware. Since its inception, the XPS 13 range has been available in a Developer Edition, which features identical hardware, but runs Ubuntu Linux.

Linux has come a long way over the years, and will at least "just about work" (one day, we'll be able to omit "about") on an awful lot of hardware. But Dell has invested considerable effort in making sure hardware behaves itself, and the Linux experience is second to none. Of course, buying an expensive laptop just because it has a working copy of Linux on it isn't the best use of one's smarts, though it may well save some shouting, wailing, and gnashing of teeth if you were otherwise going to do the install yourself. Dell provides its own package and firmware updates, and maintains an active forum of Developer Edition users.

In many ways, this sixth edition is just a refinement of a well-proven recipe. The machine is now powered by a Kaby Lake chip, which brings improved battery life and better performance. It's marginally lighter and infinitesimally smaller. It runs a newer version of Ubuntu: 16.04, as opposed to 14.04. And it comes with a new Killer Wi-Fi chip. Wi-Fi is an oft-cursed bugbear on Linux, but we found the new device worked well, easily sustaining 200Mb/s using a 5GHz connection over about 24 feet. Cosmetically, it looks much the same as the previous iteration, with a delightful woven effect atop the carbon fiber chassis, a keyboard that's satisfying to type on, and a backlight behind said keyboard, which you can softly transition between two levels of illumination. Oh, and if you opt for the touch model, you get the same delightful, vibrant display that makes anything with eyes jealous.

ASSAULT ON BATTERY

Irks remain from the previous model, too—there's still no room to put the webcam, other than off to the left below the display, nor is there room for a larger trackpad, and the squished cursor keys won't be to everyone's liking. The OS update is welcome (14.04 was released a long time ago), but Ubuntu 16.04 features Kernel 4.4, and certain Kaby Lake features were not added until 4.8. That's not to say the chip doesn't work, just that the "deeper sleep" C-states provided by Kaby Lake aren't slumbered into, so the battery is drained slightly quicker. This is a sad consequence of the awkward cadences between Kernel, distro, and hardware releases. However, there's no need to install a whole new OS to get everything working optimally; the handy Ubuntu Hardware Enablement (HWE) update can take care of that for you. With a single command, a 4.8 series kernel and an updated graphics stack are all yours. Incidentally, we managed to get about 7.5 hours of battery life looping a 720p h.264 video before installing the HWE packages, which jumped up to eight hours afterward. The non-touch model should see closer to 11 hours, having fewer pixels to illuminate. The new video drivers didn't seem to improve things—this isn't really a gaming machine, but it did manage 2015's Linux port of *Bioshock Infinite* at an almost playable 26fps, with high detail at 1600x900 resolution. –JONNI BIDWELL

VERDICT **9**

Dell XPS 13 9360

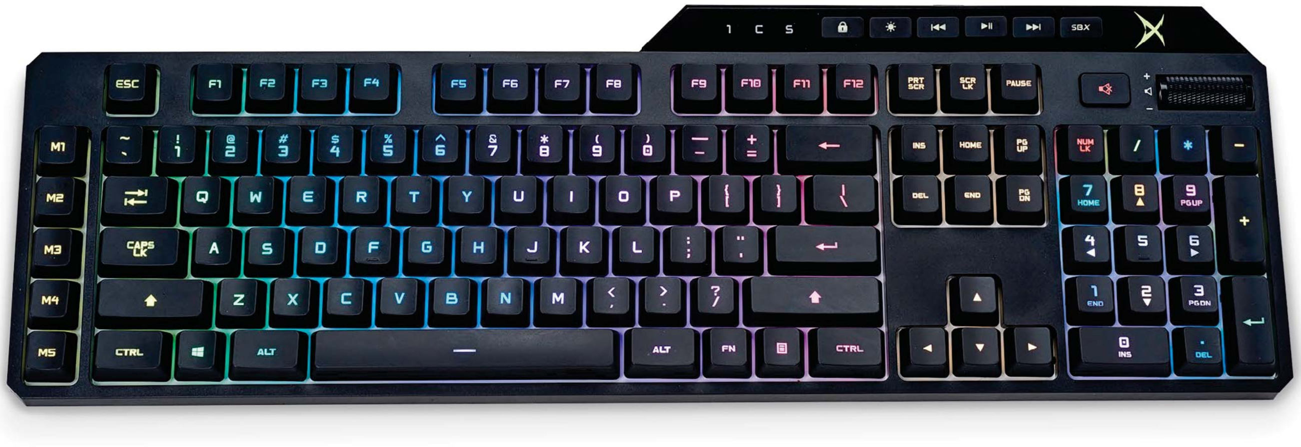
⊞ **REFRESHING** A great laptop gets a modern update; save $100 by going open source.

⊟ **SLIGHTLY STALE** Only a little better than the 9350; competition is building.

$1,850, https://dell.com

SPECIFICATIONS

CPU	2.7GHz (3.5GHz Boost) Intel Core i7-7500U
Graphics	Intel HD 620
RAM	16GB RAM LPDDR3 (1,866MHz)
Screen	13.3-inch QHD+ (3200x1800) touch panel
Storage	512GB PCIe M.2 SSD
Ports	1x USB 3.0, 1x USB 3.0 with PowerShare, 1x USB-C (Thunderbolt 3), SD card reader, headphone jack
Connectivity	Qualcomm Killer 1535 802.11ac (2.4 & 5GHz), Bluetooth 4.1
Camera	720p widescreen HD webcam with dual array digital microphones
Weight	2.9lb
Size	11.98 x 7.88 x 0.33–0.6 inches



Creative Sound BlasterX Vanguard K08

Lights and sounds—but they're not all desirable

FORGET GRAPHICS CARDS, motherboards, and monitors. The mechanical keyboard market is one of the most hotly contested hardware sectors, and rightly so. The tactile experience of interacting with your PC is almost entirely determined by the tool you use, so a change of keyboard—particularly if moving away from a soft, rubbery membrane matrix to one with satisfying bite—can have a big impact. Accordingly, everyone and their mother has a set of crunchy keys on the market, and while this is Creative's first time dipping its toe in the water, the company has already spotted the big selling point to many loose-pocketed buyers: pretty lights.

The K08's RGB lighting is equal parts flexible and obtuse. Changing it is only possible by using Creative's somewhat difficult Sound Blaster Connect software—so you're out of luck if you're not at your PC or if using a non-Windows OS—and its multilayer construction takes a while to get your head around. Put simply, you first set a multicolored animated layer, tweaking the speed, pattern, and precise color scheme. Then you add a static layer on top, enabling you to pick out individual keys, and assign them each a color of your choice, leaving the bottom layer shining through as you see fit. The combo of well-coated key caps, a white backing, and the full 16.8-million-color RGB range makes it really pop. The whole lot integrates with other hardware that supports Aurora reactive lighting, too, so you could potentially sync up your whole desk. It's a shame there's no way to change the key colors from the hardware itself, and equally that activation of the likes of Caps Lock is represented by awkward little white LEDs, rather than custom colors on the actual keys, but these are nitpicks.

In terms of overall design, Creative has outdone itself with its debut keyboard outing. The unit itself is weighty and well put together, featuring a row of lower-profile dome-switched media keys, an incredibly satisfying volume roller, and a string of five macro keys. Our lizard brains initially struggled with the position of these keys, sitting as they do along the left edge of the keyboard, but it actually makes a huge amount of sense—if your left hand is sitting over the WASD keys, they're easily reached with a nimble pinky. Customizing them is, again, done through Sound Blaster Connect, and they—and indeed any of the K08's keys—can be set to perform just about any action, from keypresses to mouse functions to custom recordings.

NOISES OFF

So, functionality, design, aesthetics: all brilliant. But a mechanical keyboard truly lives and dies by its microswitches. Creative has selected a custom switch, designed in collaboration with Omron, which it dubs the PRES ("Perceive-React-Execute Switch"). It has a shorter travel to activation than competing Cherry switches, and the switch itself is silent and rather soft; we'd place it toward the Cherry MX Black end of the audible spectrum. The K08 is absolutely fine to type on, and while it lacks the visceral edge of stiffer switches, your fingers will get tired less quickly. Beware typing fast, or at all, though: Every clack down of a keycap to the base of the unit causes a rather loud ringing sound. Even just tapping an empty space on the unit is enough to set it singing like a Tibetan bowl. We suspect this is an artefact of the springs used in these particular switches—a similar harmonic tone is present in other mechanical keyboards, but we've never known a keyboard to be quite as loud and, frankly, irritating as we found this one. We can't really fault the hardware itself—it's a quality, if rather pricey, package—but be prepared to don headphones if you're getting down to some serious work. **–ALEX COX**

VERDICT 7

Creative Sound BlasterX Vanguard K08

+ TYPING Comfortable switches; beautiful lighting; solid construction.

– GRIPING Awkward software; microswitch harmonics; expensive.

$180, http://creative.com

SPECIFICATIONS

Switch Type	Creative/Omron PRES
Form Factor	Standard
Media Keys	Dedicated
Macro Keys	5
LEDs	Full RGB
Key Rollover	26-key
Pass-Through	1x USB
Dimensions	20.4 x 8.6 x 2.5 inches
Warranty	One-year limited hardware warranty

Creative Sound BlasterX Siege M04

A precision gaming mouse. Give it a big hand—it needs one

A NAME ONCE familiar to PC builders, before onboard sound on motherboards ruined its fun, Creative Labs has been branching out as more of a general peripherals manufacturer, keeping the Sound Blaster name alive, and focusing on sound with amplifiers, headsets, and even PCIe soundcards, while also producing keyboards, webcams, and, now, mice.

The Siege M04 has a truly awful name, but one or two things going for it. The first is something of an oddity, a celebration of absence in a marketplace where more is always, well, more: the complete lack of software prediction of where your pointer will end up, and no acceleration (although you can turn this on in software). This, according to Creative, leads to a more precise mouse, and maybe when you're playing an RTS in 4K, this will be the case. In the real world, we found it very hard to notice a difference.

Adding to the chorus of precision is a PixArt PMW3360 IR LED sensor ("Gaming Grade" apparently, but given you can game with a touchpad, we're not sure exactly what this is trying to tell us), with its own 32-bit controller chip. This sort of thing is standard for pricier pointing devices these days, and, to be honest, we'd have been a bit disappointed if it hadn't featured.

The Siege is one of the first mice we've encountered that needs a firmware update before all its functions work correctly. We shouldn't complain—it's a sign of Creative's commitment to supporting the product, after all, and we had to update the firmware on a memory card reader once—but we've got used to things just working when we plug them in.

Physically, the Siege is a long and tall mouse, enabling palm-grippers to get plenty of contact, and with enough ribbed rubber patches for claw-grippers to be able to get a purchase, too. It's not going to be the claw-gripper's mouse of choice, however, and left-handers are completely out of luck, thanks to the Siege's righties-only ergonomics. It's nicely built, though, with the two main buttons as separate panels, rather than blending seamlessly into the top surface of the mouse, as we've seen from many other manufacturers, and it doesn't crunch or flex too much when you squeeze it. Lighting is confined to the mouse wheel, an X logo on top, and a strip around the bottom of the mouse body. It's almost tasteful, in fact, and easily controlled from the Sound Blaster Connect software.

UNDER THE THUMB

It's when you start to use the thing that doubts begin to creep in. Despite being the right size for the Maximum PC Test Hand, which is one of the biggest we could find, the side button placement necessitates using a position slightly too far toward the front of the mouse to be called truly comfortable. If you like to lazily rest your wrist on the desk or mousepad as you rodent about, the sniper button, low and front on the mouse's left, is completely out of reach. Every button is programmable in Sound Blaster Connect, so you're losing 14 percent of your programmability just because your thumbs are stumpy. The top two side buttons sidestep any problems, by being long enough to press from any position, while the wheel has a decent rubber tire, and rolls easily under gentle finger pressure.

Creative's stab at a mouse isn't bad at all, let down only by some suspect button placement and excessive length. Its main issue is that, for slightly less money, you can get several models of Logitech mouse, including the G502 Proteus Spectrum. And that's a problem Creative is going to have to work hard to overcome. **–IAN EVENDEN**

VERDICT
7

Creative Sound BlasterX Siege M04

+ **SIEGE** Solid construction; enough buttons; subtle lighting.

− **SALLY** Poor button placement; plastic feels slightly cheap.

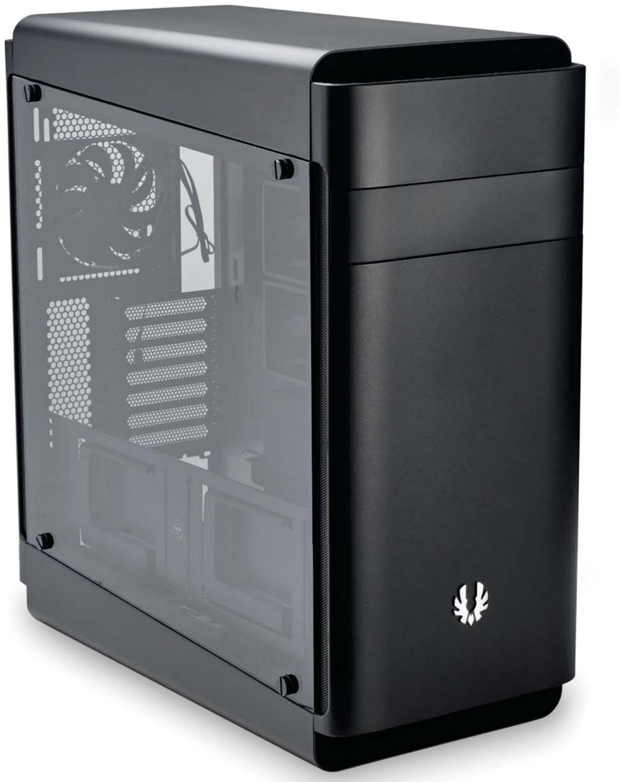
$80, http://creative.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	200–12,000 dpi
Sensor Model	PixArt Technologies PMW3360
Polling Rate	100Hz
Programmable Buttons	7
LEDs	One zone—16.8 million colors
Cable Length	6 feet
Weight	5oz

BitFenix Shogun

The Taiwanese company breaks the tempered glass barrier



OH, BITFENIX, you've really wowed us in the past with your eccentric designs. And your desire to innovate in a field that's becoming ever more overcrowded with a barrage of rectangular boxes has inspired us in ways you could only imagine. The Shinobi, the Prodigy, the Phenom, that soft-touch finish, the 230mm intake fans—all fantastic ideas.

The Shogun is the latest in BitFenix's vast arsenal of case designs. A mighty beast of bedlam, it's more akin to the heritage of the Shinobi and Prodigy than any other chassis in its vast line-up. And, boy, is it a beauty! Although it lacks the soft-touch finish of its predecessors, the curved aluminum base and roof panels add an elegance that truly awes—though more when you see it in person than any photography could ever show. Couple that with its unfettered airflow access, and it's plain to see why this was such a solid idea.

But it's the stance of the chassis that's most impressive. Like most premium cases released over the last six months, the Shogun features tempered glass side panels, front and rear. Unlike the competition, however, the panels are slanted down the side of the case. This gives a fantastic edge to the square design, mixing curves with straight lines to form an amazing aesthetic appeal.

The Shogun's not just a pretty face, either. It comes packed with some neat additions, too, including two side-panel-facing SSD mounts with RGB LED lighting, configurable with Asus's Aura Sync, and three "GPU Safe" mounts, that help reduce GPU sag on long cards and during travel.

Cooling, however, is where the Shogun really shines. Supporting up to three 140mm fans in the front, three 120mm or two 140mm fans in the roof, and one 140mm fan in the rear, the liquid-cooling potential is massive. With additional recessed radiator mounting points embedded into the chassis itself, it makes any liquid or air-cooling setup a reality, with little to no fuss.

There's no PSU cover as such, but the SSD mounting panel does lend itself to obscuring the vast majority of the power supply and any supporting cables from a sideways glance. The only way you'll spot the PSU or its associated cables is by peering down into the chassis from above. Hardly a run-of-the-mill scenario.

Total hard drive support is elegantly covered by the two RGB 2.5-inch mounts on the side, another two on the rear of the motherboard tray, then a further six 3.5-inch drive bays, which can be converted to work with 2.5-inch devices as well.

The Shogun reminds us of its now-ancient Shinobi cousin, but with a lot more modern conveniences. Although the SSD mounting positions may not be to everyone's tastes, it's hard to argue that BitFenix hasn't got everyone's configuration covered. Whether you're an enthusiast liquid-cooler, a weekend AIO overclocking junkie, or an air-cooled 3D-modeling professional, it's likely the Shogun can do it for you. **–ZAK STOREY**

VERDICT **9**

BitFenix Shogun

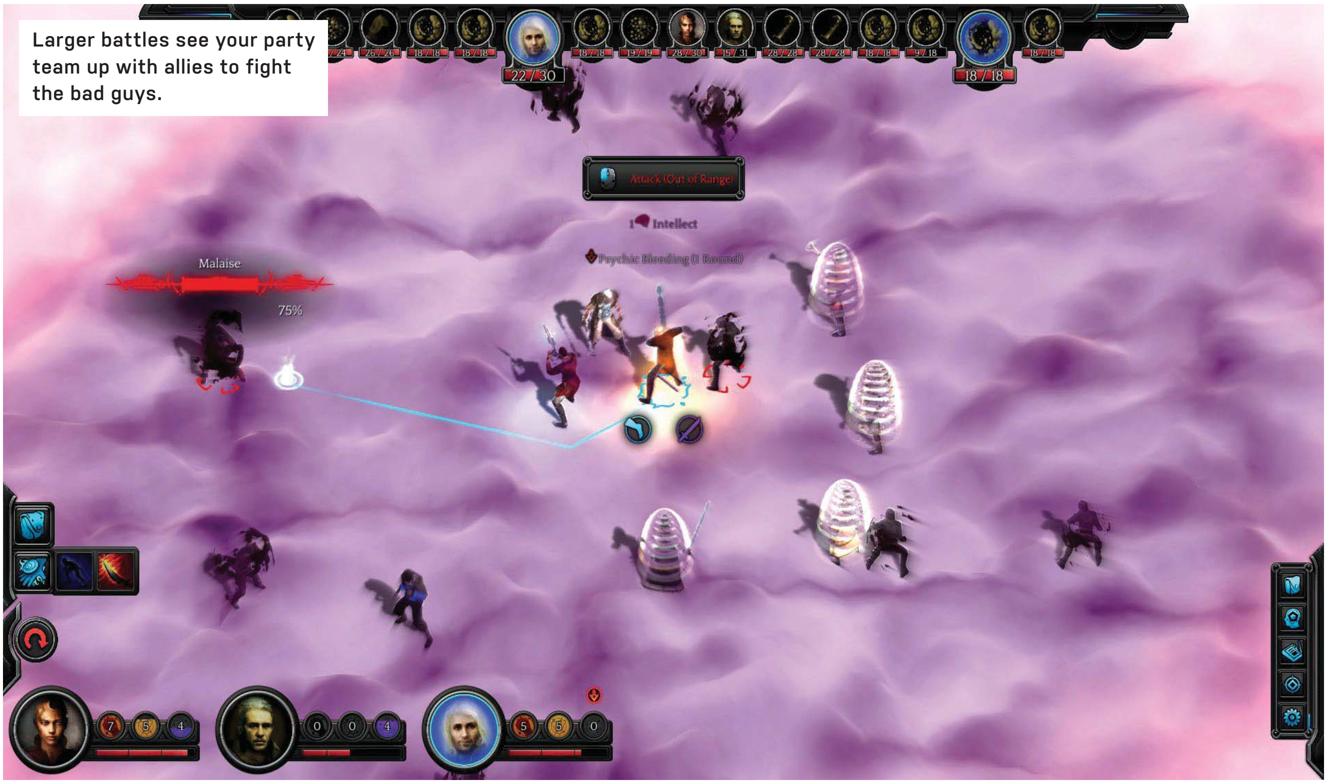
⊞ **CRYSTAL** Solid design; nice feature set; clean style; angled glass side panels; supreme cooling support.

⊟ **SMUDGE** Steel interior chassis could be nicer; SSD mounts not for everyone.

$160, www.bitfenix.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	E-ATX, ATX, microATX, Mini-ITX
Colors Available	Black
Window Available	Yes
3.5-Inch Support	6
2.5-Inch Support	6
Radiator Support	420mm front, 360mm roof, 140mm rear
Fan Support	3x 140mm front, 3x 120mm roof, 1x 140mm rear
Dimensions	9.9 x 22.2 x 20.7 inches
Graphics Card Clearance	16.1 inches
CPU Tower Clearance	6.9 inches
Weight	36lb



Larger battles see your party team up with allies to fight the bad guys.

Torment: Tides of Numenera

Read all about it, then read some more…

WE DON'T KNOW WHAT you were doing in the late '90s, but we were playing *Half-Life,* setting up disappointing bot-matches in *Unreal Tournament* because V.90 modems were rubbish, and gazing at the BioWare and Black Isle game boxes on the shelf, wondering when we'd have time to finish them. The very best of these, played from the isometric viewpoint of the Infinity Engine, was *Planescape: Torment.* And 18 years later, we have a "spiritual successor" in the form of *Tides of Numenera.*

Switching settings from *Dungeons and Dragons'* Planescape to Monte Cook's Numenera, *Tides* looks the part thanks to *Pillars of Eternity's* engine, and explores *Tormenty* themes of memory, identity, and rebirth. Numenera was begging for the videogame treatment—as much sci-fi as fantasy, it sees a primitive far-future civilization coming to terms with the detritus left by the eight (or more) societies that have come before, their advanced technologies seeming like nothing less than magic, their functions a puzzle that may never be solved. These are the Numenera, and even the soil contains multitudes of discarded technology, you read one character say.

Ah yes, the reading. This isn't a fully voiced game. If it were, they'd still be recording in 10 years' time, so great are the conversation options. Due to the sheer amount of lore, character backstory, and plot-critical information to be gleaned from both bystanders and mysterious robed figures phasing in and out of the universe, the need to talk to everyone is great if you want to truly understand this world. When a game is this close to interactive fiction, you are forced to slow down, take a step back, and contemplate what you've learned—something of a novelty in a modern gaming landscape that prizes twitch skills so highly. The lack of voices means that when you do run into a character who can make a noise, you know you've found an important one.

CAST YOUR MIND BACK

You are the Last Castoff, a husk left behind when an apparently god-like being transferred its consciousness into another body. As with all castoffs, you achieved sentience—and just in time, in your case, as you crash through a dome and into the Ninth World. Your journey through this world—to find out who you really are as much as understand your "sire"—is up to you. As you wander, you pick up a party, learn skills, and maybe fight a bit—although it's possible to avoid violence as much as you want. You can talk your way out of any situation, sneak around in the shadows, and influence the Tides—colored personifications of emotion and feeling—with your actions, to alter the way characters react to you.

It's an enormously deep system, albeit one that can appear opaque. Notifications of shifts in the Tides appear before you even know what they are, and the section of the character sheet telling you which colors are dominant is too small, and not labeled. The whole thing feels old-fashioned, which we guess is part of the point. Games like this still get made—*Pillars of Eternity,* the *Baldur's Gate* remakes—but are the exception rather than the rule, and when nostalgia is part of the marketing strategy, a little clunkiness and a whole lot of text are exactly what we expected. **–IAN EVENDEN**

VERDICT 8

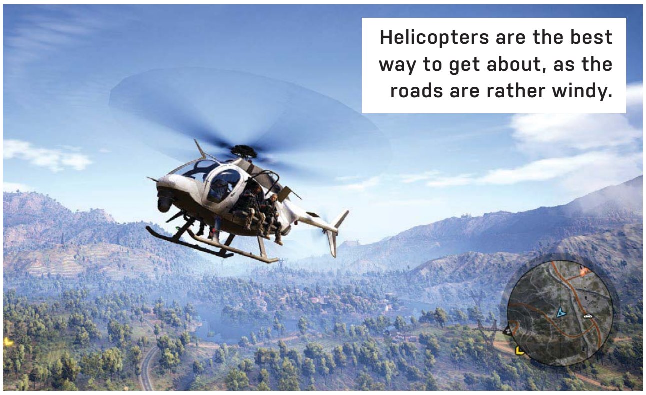
Torment: Tides of Numenera

+ TIDES Huge story; sprawling world; deep systems.

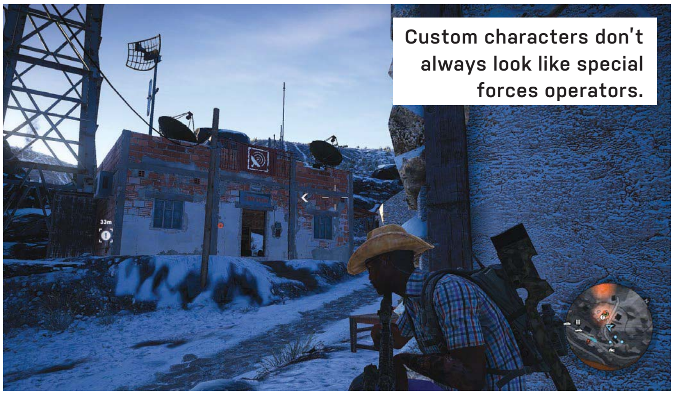
− SLIDES Graphics less than amazing; reading takes time.

RECOMMENDED SPECS Intel i5 or AMD equivalent, 8GB RAM, GeForce GTX 560.

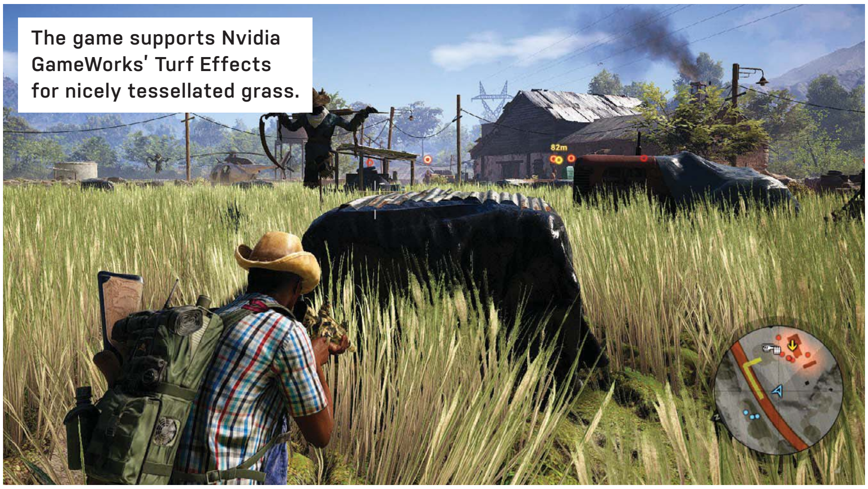
$45, http://inxile-entertainment.com, ESRB: M



Helicopters are the best way to get about, as the roads are rather windy.



Custom characters don't always look like special forces operators.



The game supports Nvidia GameWorks' Turf Effects for nicely tessellated grass.

Why you'd drive one of these over dirt roads is beyond us.

Ghost Recon Wildlands

In which your crack squad takes on the crack squad

WHEN WE REVIEWED *Far Cry Primal*, we lamented that a Ubisoft studio had "made its game again." Well, it's happened once more, this time dragging a Tom Clancy franchise into the open world with it.

Your elite combat squad is in Bolivia to take down the head of the Santa Blanca drug cartel, a man with more lieutenants than the entire US Army. Those lieutenants need to be reduced to a thin red mist before you can have a crack at the top man.

Bolivia is cut from huge and beautiful cloth, but it's a diaphanous fabric that exposes the size-zero bones of the supporting structure. Outposts are the bolts that hold the game together, and you raid them in the same way you did in *Far Cry 4*, collecting intel, weapons, skill points, and other goodies, until you're ready to take on the area's boss character, after which you can move on to another part of the country (there are many), and do it all again.

The feeling of being able to tackle outposts in any way you want is palpable—frustrated by being spotted after a couple failed stealth infiltrations with the aim of stealing a car, we landed a helicopter on the garage roof, ran down a fire escape, and drove off into the night. A swift grenade took out a boss with a minigun, who could have leveled our entire squad. But this open-ended approach doesn't mask the fact that it's the same old thing over and over again.

There is some attempt to mix things up, with frantic cross-country chases to switch off radio beacons, convoys full of resources to be hunted down, and skills to be learned that boost your character's abilities. The game is also designed with co-op play at its heart, as illustrated by the Sync Shot, which sees your team take out up to four bad guys at once. With no buddies to play with, you're left with bots, who display the useful ability to see drug enforcers through hills and walls, and can teleport to catch up with you.

After playing "properly" in single-player, we soon learned to leave the bots behind, confident that they would pop into existence on the back seat of our truck. Teleporting bots make the dirt bikes you find dotted around useful for reconnaissance, as you can be sure your AI teammates will be there when you find some cartel soldiers, even though you left them back at base.

With this structure and focus on base-exploding, perhaps the most recent analog to *Wildlands* is *Just Cause 3*, rather than *Future Soldier*. Run in, cause chaos, get out is as valid a way to play as sneaking around unseen, but the Ghosts' drone is a poor replacement for Rico's grappling hook.

Wildlands can be a hoot in co-op, as the interaction with real people glosses over its repetitive nature. A focus on breadth of experience—not landscape—might have gone a long way toward making this a more satisfying open-world game. **–IAN EVENDEN**

VERDICT 7

Ghost Recon Wildlands

+ **MOSTLY** Beautiful landscape; loads of content; co-op funsies.

− **GHOSTLY** Repetitive; repetitive; repetitive.

RECOMMENDED SPECS Intel i7-3770 or AMD FX-8350, 8GB RAM, GeForce GTX 970 or AMD R9 390.

$60, http://ghostrecon.com, ESRB: M

LAB NOTES

JARRED WALTON, SENIOR EDITOR

Intel Optane Memory

Optane makes an appearance in the wild

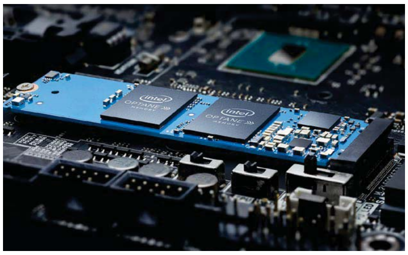
INTEL RECENTLY REVEALED its newest SSD solution, the Optane SSD DC P4800X, a datacenter drive boasting extreme endurance. The 375GB model will be rated at 12–20PB of writes, or 30 complete drive writes per day for three to five years. But endurance isn't the only impressive aspect of Optane.

The drive will also have exceptional latency, typically less than 10 microseconds up to the 99th percentile. By comparison, Intel's DC P3700 is a few thousand microseconds under similar workloads. Perhaps most importantly, Intel is promising breakthrough performance at low queue depths—even though most SSDs are rated at QD32, in the real world, no SSD is running anything beyond maybe QD8, with over 95 percent of operations taking place at QD1–4.

All of that should prove incredibly useful for servers, but we will have to wait until the second half of 2017 before we begin to see consumer versions of the drive. Which is probably for the best, because even the 375GB model will set you back a staggering $1,520, never mind the future 750GB and 1.5TB models.

Optane Memory is a different story, slated to launch within the month—we'll have actual performance metrics available next issue. Optane Memory is less exciting, mostly because it has a limited area of use. For $45, Kaby Lake CPU and motherboard users can get a 16GB Optane Memory adapter that will improve system performance via intelligent caching, or $80 will buy you a 32GB module.

And there's the rub: How will a 1TB HDD plus 16GB Optane Memory solution fare compared to just buying a 480GB budget SSD? When the data you're after is on the Optane cache, performance should be excellent, but if it's not, and you have to go to the hard drive… get ready to visit Sluggishville, USA. On the other hand, if you already have a Kaby Lake system, with or without an SSD, Optane Memory should make it better.



How will Optane Memory perform? We'll let you know next month.

ALAN DEXTER

Executive Editor

I recently sat down with Microsoft's Peter Orullian, to talk about Game Mode and Beam, the new gaming-focused features shipping with the Windows 10 Creators Update. The idea behind Game Mode—improving game performance—is good, but it will be tricky to test on our benches, because it's designed for mainstream machines that come stuffed with bloatware and clutter. When we test, we ensure there aren't any background tasks throwing off the numbers, but we'll endeavor to find a suitable machine to showcase what it can do. Beam, meanwhile, is a competitor to Twitch, and broadcasting after the update looks super-easy to achieve. We'll have more on both soon.

ZAK STOREY

Reviews Editor

Around 95 percent of the work I do for my job here at *Maximum PC* is carried out on my trusty Windows system. However, I also have to use an aging 2011 iMac, to transfer files across to our artwork team via internal services, and to use our bespoke magazine management software. This means that I need to have two separate sets of peripherals on my desk at all time. However, there are rumors that suggest Logitech may be working on screen-sharing software that enables you to use one set of peripherals across multiple systems. From Windows to Mac to tablets, regardless of network, as long as your mouse cursor is on that screen, your keyboard will work there, too. Count me in!

Editors' Picks:
Digital Discoveries

Tuan Nguyen, editor-in-chief, and Bo Moore, technology editor, get fired up about new machines

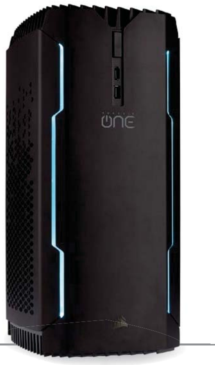
THE CORSAIR ONE

I recently had the chance to play with a very special system from Corsair, called the Corsair One—creative, I know. Sure, at first glance, it's a high-performance gaming PC, packed tightly into a very svelte chassis made from aluminum. But what makes the Corsair One stand out isn't its design or its performance; the Corsair One is special because it marks a major milestone in Corsair's history books.

If you've been around the scene long enough, you'll know that, originally, Corsair was primarily a DRAM module company. Then it started producing cases, and now it is a popular choice for all sorts of computer accessories. And I have to say, the company has been doing a damn good job in all of its product categories. Save for a few major bits, Corsair is now at the point where it makes almost every part of a complete computer. So, it makes perfect sense that the company is launching the Corsair One—this is what makes the system special.

As a raw machine, the Corsair One is very well designed. The engineers and designers over at Corsair have used every possible nook and cranny of the chassis, and the design elements are as functional as they are good-looking. It's extremely well made, and I've gotta give it to the company—I haven't been this excited about a complete pre-built for a very long time.

$1,800,
www.corsair.com



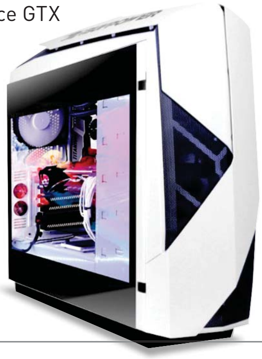
IBUYPOWER SNOWBLIND

I've never been one for flashy RGB lighting arrays. I'll take an understated, minimalist box over aggressive "gamer" stylings any day. But I might have found the thing to change my mind. I recently had the chance to go hands-on with iBuyPower's new Snowblind PC, a pre-built system that really takes case aesthetics to the next level. In lieu of a traditional side panel, Snowblind has a semi-transparent LCD screen that can display everything from dynamic graphics to real-time hardware monitoring widgets.

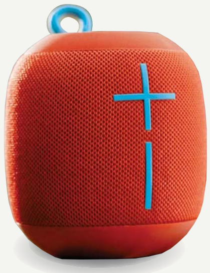
The case's side panel is a 1280x1024 LCD screen that uses the internal lighting of the case for backlighting. It connects to your GPU via a short DVI cable, so Windows recognizes it as a second (or third, or fourth) monitor that you can set to display widgets, graphics, or whatever you want. My favorite was leaving the panel mostly transparent—showing off the manicured insides—save for a handful of Rainmeter widgets displaying CPU usage, GPU load, and time.

Unfortunately, you can't buy Snowblind as a standalone case—not yet, at least. At launch, it's only available as a full, pre-built system from iBuyPower, starting at $1,549 for an Intel Core i5-7400, 8GB of RAM, a GeForce GTX 1070 GPU, and 1TB of storage. Here's hoping the standalone comes soon—I want to build inside one.

$1,549, www.ibuypower.com



GEEK TESTED & APPROVED



UE Wonderboom

THIS IS REALLY GOOD. Seriously, it's so good. I've never been more impressed with a Bluetooth speaker than I have with the UE Wonderboom. To be fair, this was the first UE device I've ever tested, and only having the likes of Bose and Razer to compare it to may have muddied my views a touch as to what's "good," but even so, as a connoisseur of fine audio, I like to consider myself pretty well versed in the nuances of treble, bass, and mids.

So, what's so special about the Wonderboom? Well, multiple things: It's a small apple-shaped object, with 3D positional sound, waterproofing (IPX7), and a no-nonsense setup that just works. Unlike its Boom predecessors, it doesn't come with any apps, or messing about—simply hit the Bluetooth pairing button at the top, find it with your device, connect, and you're good to go.

Once connected, you can actually pair the Wonderboom up with another one, to create a stereo setup (although it won't pair beyond two), and use it wherever you like. It has a 30m range for mobile devices, too. It's portable, and comes with a pretty meaty battery, allowing up to 10 hours' playback. That said, there's no LED indicator for remaining battery life, but if you press the plus and minus volume controls twice simultaneously, you hear an audible indicator telling you many bars of battery you have left.

Couple all that with exceptionally crisp audio, and a price point of around $80 (to be confirmed), and the Wonderboom rounds out to be an exceptionally pleasant addition to any techie's arsenal. Whether you're camping in the wilderness, traveling, or just using it in your kitchen, it's right on point. **–ZS**

$80, www.ue.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Link Aggregation
> VPN Primer
> The Next Reality

Aggregating Problems

Thanks for the great article in the Spring issue about boosting my NAS with link aggregation. And timely, too. I had just run Ethernet cable up to my second floor to serve another PC and a smart TV up there, and was looking into utilizing both ports on my QNAP TS-251, since two or three devices may be accessing it at a time now. I use my NAS for media streaming and computer backups. Since I hadn't purchased a switch yet, I just picked up the same switch you used (TP-Link SG-2008). I was able to follow your tutorial to the letter. It was spot on, but one tip, though, for anyone using this particular switch: After setting up LACP and verifying everything works, you'll want to click "Save Config" on the main menu, to make the changes permanent. Otherwise, if the switch loses power, it reverts to factory defaults, and you lose your settings. I found that out the hard way when I decided to move the switch to a new location after setting it up!

I'm semi-comfortable with networking, but I'm far from an expert, and I had one hell of a time getting things to work initially. I have a cable modem and wireless router (D-Link DIR-868L). I couldn't log on to the switch unless I removed the router from the network. I was able to do that and get LACP set up just fine, but once I hooked the router back up: no switch access again. The QNAP console confirms both ports are trunked, though.

I assume I may have an IP address conflict. I ran across a neat little program called NetScan Tools Pro, which tells me more info about my network than I knew existed! It says there are no duplicate IP addresses, and I couldn't decipher any other problems with the tests I ran. FWIW, my Windows 10 PC and my router are both using default network settings for the most part, except I set them both to use Google's DNS servers. They've been set up that way for a long time without issue. My cable modem is pretty well locked down, of course. My ISP charges $25 per month just to have a static IP address set on it. No thank you!

So, do you think I should just leave well enough alone, since everything seems to be working fine? Or is there a reasonably simple fix to get things set up right? I don't want to go mucking around with a lot of network settings and screw something else up, but I don't want any potential future problems either. Perhaps we could use a feature article on home networking one day soon?

–Scott Holcomb

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: I passed on your details to the author of the article, Nick Peers, and he responded with, "The switch defaults to 192.168.0.1, which conflicts with many routers. You need to manually set the IP address of the switch to something else." Nick followed up by saying he'll drop you a line directly, as it's not easy. On to your last point: I think a feature on the optimal way of setting up your home network is a great idea, and it's something you'll see in a forthcoming issue.

[NOW ONLINE]

TWEAK WINDOWS FOR BETTER GAME PERFORMANCE

If you've ever examined the task list after a Ctrl-Alt-Del command, you've probably wondered whether all those background processes affect the gaming performance of your system. Even a clean, fresh Windows installation sprouts a lengthy list of apps, tasks, and services that runs to dozens of entries long.

The concept of pruning this process tree to increase performance isn't new. Utilities claiming to do this have been around so long, the idea has made its way into Windows itself, as outlined in our look at Win 10's upcoming Game Mode. http://bit.ly/2nRVQLT

TORCHLIGHT

↘ submit your questions to: comments@maximumpc.com

Network Primer

Can the magazine consider running a article on the use of a VPN, and show any value in using that kind of technology?

–Hinton Thomas

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: Virtual private networking has traditionally been used by home workers to log on to their work's intranets to get critical work done securely. This is still their main use today, although more and more we're seeing VPNs used as a way of obfuscating network traffic to avoid geo-restrictions and censorship. We've looked at the process of setting up and running VPNs before (in fact, if you turn to page 68, you'll find a guide on how to turn your home PC into a VPN for accessing while you're out and about), but we've only ever touched on what VPNs are in passing. We'll look at covering this in more detail in the future.

Discount Drive

I keep seeing in your builds that you always have decent-priced SSDs. Where do you get the prices from?

–EJ Cross

REVIEWS EDITOR ZAK STOREY RESPONDS: We use a combination of Newegg, Amazon, PC Part Picker, and NCIXUS. We generally avoid one-off, short-term sales, because the lead time on the magazine means that these can be out of date by the time you read it. So, you shouldn't have a problem finding drives for the prices we quote.

Virtual Revolution

With rumors circulating and people guessing, I'm one of them. Here's my guess: Valve/HTC are working on the next iteration of Vive. If we see anything this year, I think it's more likely it would be Iteration 1.5. Sort of a Tick, Tock, like Intel's strategy has been in the past for optimizing its architecture. I think it is more likely (for development) that we see a full hardware update some time next year.

–Matthew Sumrada

EDITOR-IN-CHIEF TUAN NGYUEN RESPONDS: HTC is said to be working on a completely untethered version of the Vive—that is, one without having to use Lighthouses for 3D room-scale type movement. This is very much like what Oculus demoed to us during the last Oculus Connect event, a few months ago. Everyone is working on how to get the imagery from the desktop GPU over to the headset wirelessly. HTC is trying to work that out, but right now the wireless stuff is prone to interference and range issues, as well as latency. You cannot have latency when it comes to VR, or else you'll get sick immediately. HTC recently demoed an external 3D tracker module, but that is likely to be integrated into the headset on the next iteration of the Vive.

Window of Things

Could you please do some coverage on Microsoft's Windows 10 IoT initiative? It seems to be the perfect bridge between your Raspberry Pi projects and hardware/build enthusiasm. Extending Windows to the Pi via real-world controls is exciting to consider, but extremely hard to find good coverage on. **–Steve Hysick**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: Like you, we were very excited about the potential offered up by this initiative, but once we got our hands on a build, it became apparent that this was aimed at fairly serious development, rather than the at-home hacking that typifies most Pi projects. Having said that, we've just taken another look around (in response to your email), and there are a few more projects now. You can find plenty on the official site—https://microsoft.hackster.io—and grab the software from https://developer.microsoft.com/en-us/windows/iot/getstarted.

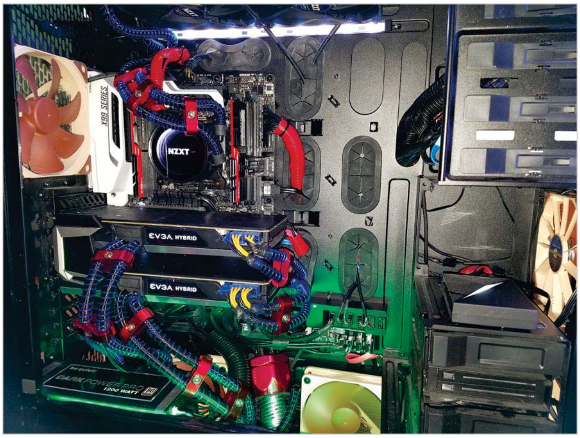
Sound System

When building computers for digital music production, optimizing for reduction of latency equals or exceeds that for gaming. I wish you would start monthly columns about builds, hardware, and software tweaks for high-power music rigs. Digital music magazines tend to slide past the issues of the actual computer and operating system software.

–Terry Livenick

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: We love a niche here on *Maximum PC,* but a monthly column may be taking things a bit too far. Even so, we'll investigate this topic and see what we can find out. ⏻

[READER SPOTLIGHT]



FUEL-INJECTED PC

Last year, I put together what I felt was an "ultimate build," and decided this time I was going to do the wiring the right way.

For now, I'm running three AIOs—two EVGA hybrids for my Titan (XP)s, and one Kraken x62 (a hardline custom loop is in the works). The tubes were driving me nuts, and Googling didn't uncover much.

I also happen to be an avid (though not always successful) weekend mechanic, and had just finished a fuel injection conversion. I had a bunch of 3/8-inch double tube clamps in red anodized aluminum. They fit the AIO tubes perfectly. That, with a little anti-kink, and the tubes I've been trying to hide now actually look good.

Just wanted to pass this along. I've attached a picture of my build. The clamps I used are from Earl's, and you can get them in any automotive enthusiast store (I got them from Summit Racing). And, yes, that's an aluminum lower radiator hose on the bottom that I used to route the power supply wires.

In case you're interested, my rig specs are: a Corsair 900D case, Asus X99-Deluxe, Intel 6950X, Kraken x62, dual Titan (Pascals) in SLI, with (modified) EVGA Hybrid AIO water cooling, 32GB DDR4 Corsair 3200, and a 500GB Samsung 950 Pro M.2. The front control panels are both Lamptron; the top is an FC10 nixie tube 4x fan controller, the bottom is an FC5. **–Jim Glass**

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INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Evolv ITX	$70
PSU	EVGA 450B Bronze	$45
Mobo	MSI B250I PRO Mini ITX	$90
CPU	Intel Pentium G4600	$90
GPU	EVGA GeForce GTX 1060 Gaming 3GB	$190
RAM	8GB (2x 4GB) Patriot Viper Elite DDR4 2400 **NEW**	$58
SSD	Kingston SSDNow V300 240GB 2.5-inch SATA **NEW**	$80
HDD	1TB Hitachi Deskstar 7,200rpm 3.5-inch SATA	$58
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit	$16

Approximate Price: $697

IT FEELS ODD to say that Intel is currently the best budget option you can invest in, but that doesn't make it any less true. Intel's aggressive single-core performance on the Pentium G4600 makes it a competitive gaming chip, capable of hanging with the best of them. And short of going with refurbed or second-hand parts, this system represents the best bang for buck for a casual desktop PC.

This issue has seen a few changes, though—amazingly, memory prices haven't changed this month, but SSD prices have crept up, so we've dropped the Z400s Sandisk for an Ultra II; it has a touch less storage, but is no less of a performance king than the Z400s. On top of that, we swapped out the G.Skill memory for a kit of Patriot Viper Elites instead, because it saved us a grand total of $5. The biggest conundrum was the Hitachi Deskstar, eating up our budget by another $8 compared to last month.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	NZXT S340 Elite	$100
PSU	EVGA SuperNOVA 550 GS Gold	$80
Mobo	MSI Z270 SLI Pro Series **NEW**	$140
CPU	Intel Core i5-7600K	$240
Cooler	Corsair H100i v2	$120
GPU	Zotac GeForce GTX 1070 **NEW**	$380
RAM	16GB (2x 8GB) G.Skill V Series DDR4-2400	$103
SSD	256GB Intel SSD 600p M.2 PCIe	$100
HDD	Western Digital Blue Series 1TB 7,200rpm	$50
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,413

NO MAJOR CHANGES THIS ISSUE for our mid-range system. We did swap out MSI's Gaming M3 series motherboard for the SLI Pro, though, which comes in a slick black finish, and with all the major features that its slightly more expensive brother offers. We also swapped out the EVGA GPU for a Zotac GTX 1070.

Although Ryzen would probably be the best contender for this mid-range build, the 5-series chips haven't launched yet, and we're still seeing teething problems in games with these chips and memory frequencies. Expect the bugs to be ironed out quickly, but for now, it's a waiting game to see what effect AMD has on the industry.

Interestingly, the memory price hike has slowed, while spinning platters are still on the rise. We're seeing small price increases across the board, bumping up our total, but thanks to swapping out the MSI Gaming M3, we can negate those rises, even if it's only by $4.

TURBO

SEVERAL FAIRLY SUBSTANTIAL CHANGES this month, the biggest being the case. We decided to drop the Evolv ATX for another Phanteks beauty: the P400S Tempered Glass Silent Edition. Still touting a ridiculous amount of airflow, stunningly clean design, and a white aesthetic, this midi tower is more than capable of supporting all the hardware in our build, and also comes in at $80 cheaper than the Evolv.

Next on the chopping block was the EVGA PSU. Although a great choice, we decided to go for Corsair's RM850X, in case you want to opt for a custom sleeved cable kit from the likes of Corsair later on. We also took a long look at the price of graphics cards—there are some great deals on GeForce GTX 1080s at the moment, but ultimately we decided to go with the newer 1080 Ti. We also switched to a single 5TB WD Black HDD, rather than last month's two 2TB drives.

We swapped out the memory too, picking up HyperX's Savage 2666 kit, as we can verify that it works on this mobo, with this chip. Ryzen's memory woes aren't as debilitating as many people say, but they do exist. Higher frequency memory kits, although available, are limited in quantity. A predictable teething issue from AMD's latest architecture.

Our biggest change, of course, is the GPU. The GTX 1080 Ti is king of the hill when it comes to gaming performance right now—it overclocks like a champ, and makes 4K gaming genuinely enjoyable. However, if you want to save cash, a GTX 1080 offers just as good an experience.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Phanteks Eclipse P400S Tempered Glass Silent Edition	**NEW**	$90
PSU	Corsair RM850X Modular Gold	**NEW**	$120
Mobo	Asus Crosshair VI Hero		$255
CPU	AMD Ryzen 7 1800X		$500
Cooler	NZXT Kraken X62 280mm AIO		$160
GPU	EVGA GeForce GTX 1080 Ti	**NEW**	$700
RAM	32GB (2x 16GB) HyperX Savage DDR4-2666	**NEW**	$292
SSD	1TB Samsung 960 Pro M.2 NVMe SSD		$630
HDD	5TB WD Black 7,200rpm 3.5-inch SATA	**NEW**	$220
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $3,067

UPGRADE OF THE MONTH

NVIDIA GEFORCE GTX 1080 TI

GTX 1080Ti
NVIDIA

There's nothing like a piece of maximum whoop-ass in GPU form, and that's exactly what you get with the GTX 1080 Ti. Despite Nvidia's own price gouging for the last year or so, the GTX 1080 Ti offers unprecedented performance at a price that's just too good to pass up. Combine that with an immense amount of fun in the overclocking department, plus fantastic 4K and 1440p performance, and it quickly wraps up to make this one of the most interesting GPU launches of the last two years: A Titan X at a GTX 1080 price. Not only that, but it has also forced the rest of Nvidia's 10 series line-up to move down the price chain to something a lot more reasonable.

$700, www.nvidia.com

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